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BURROUGHS WELLCOME FUND

1998

ANNUAL REPORT

The Burroughs Wellcome Fund
is an independent private foundation
established to advance the medical sciences
by supporting research
and other scientific and educational activities.

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BURROUGHS
WELLCOME
FUND

1998 ANNUAL REPORT

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Depicted in BWF's logo, the eye of the ancient god Horus is widely considered a symbol of health

History of the Burroughs Wellcome Fund

The Burroughs Wellcome Fund, founded in the United States in 1955, has roots in 19th-century England, where two young American pharmacists formed a partnership to establish an innovative pharmaceutical company.

Silas Burroughs and Henry Wellcome, both of whom were educated in the United States and had represented U.S. drug companies in the United Kingdom, recognized that a revolution then taking place in the American pharmaceutical business offered great opportunity for expansion and success abroad. This revolution, which had originated in England but was finding its fullest expression in the United States, centered on the development of "compressed" medicines—pills—that could be mass-produced and packaged for wide and rapid distribution. Because they delivered standardized, reproducible dosages, these new tablet formulations were viewed as being safer and more effective than the common potions and powders of the day.

The two men formed their partnership in London in 1880, and their enterprise—known as Burroughs Wellcome and Co.—prospered. After Silas Burroughs died in 1895, Henry Wellcome directed the growth of the company into an international network, with notable expansion in the first two decades of the 20th century. New subsidiaries were opened on several continents and in numerous countries, including the United States. As the business grew, Wellcome held firm to his strong belief that research was basic to the development of excellent pharmaceutical products—a belief he put into practice by establishing the industry's first research laboratories.

In 1924, Wellcome consolidated all of the company's holdings, both in England and abroad, under a corporate umbrella that he named The Wellcome Foundation Ltd. The scope of the activities involved—including businesses, museums, libraries, and numerous research projects on several continents—is a measure of Henry Wellcome's vision, energy, and contribution to international science. This was acknowledged by many honors, including a knighthood conferred on him in 1932 by King George V.

When Sir Henry died in 1936, his will called for vesting all of the corporate shares in a new entity—the Wellcome Trust. The Trust's charge was to devote all of its income to research in medicine and allied sciences and to the maintenance of research museums and libraries dedicated to these fields. Over the decades, the Trust has supported a vast array of biomedical research in the United Kingdom and other selected regions of the globe, and the Trust has grown to become the world's largest charitable foundation devoted exclusively to the biomedical sciences.

In 1955, Sir Henry Dale, one of the Trust's original trustees and its chair for 21 years, and William N. Creasy, president and chair of Burroughs Wellcome Co.-USA, envisioned a U.S. extension of the Wellcome Trust—and so was born the Burroughs Wellcome Fund, which would be supported by the U.S. company. Both men saw BWF as a natural extension of Henry Wellcome's will and its intent, as well as an acknowledgment of his native land and the great success of the American branch of the Wellcome enterprise. For nearly 40 years as a corporate foundation, BWF focused its modest financial resources in selected areas to advance scientific knowledge.

In 1993, BWF received from the Wellcome Trust a $400 million gift that altered the Fund's very nature. The gift enabled BWF to become a completely independent foundation, with no direct ties to its founding company. (Nor is BWF affiliated in any way with what has come to be Glaxo Wellcome Inc., which emerged in 1995 when the pharmaceutical company Glaxo acquired all of the Wellcome commercial holdings.) BWF stands as an independent private foundation whose mission is to advance the medical sciences by supporting research and other scientific and educational activities. Aided by the Trust's gift, the Fund now pursues an enhanced role in biomedical research in the United States and has expanded its support to include Canada.

The list of individuals on both sides of the Atlantic who participated in instilling the Wellcome legacy in the Burroughs Wellcome Fund is a long one. William Creasy remained at BWF's helm for more than a decade, guiding development of the Fund's mission and scientific activities. William Dowling, who had developed the legal structure of the Fund, served as its chair from 1971 until 1974. George Hitchings, Ph.D., a Nobel laureate who spent most of his career with Burroughs Wellcome Co., served as BWF's president from 1974 until 1990, and his leadership strongly reinforced the Fund's belief in the essential link between basic research and practical applications in medicine (see page 96). And Howard Schaeffer, Ph.D., a pioneering chemist who chaired BWF from 1991 until 1994, played a significant role in helping the Wellcome Trust carry out its gift to the Fund.

The importance of curiosity-driven research, as endorsed by Henry Wellcome in the early years of the century, continues to guide the Burroughs Wellcome Fund.

The importance of curiosity-driven research, as endorsed by Henry Wellcome in the early years of the century, continues to guide the Burroughs Wellcome Fund. BWF seeks to accomplish two primary goals through its programs: to help outstanding scientists early in their careers develop as independent investigators, and to advance fields in the basic medical sciences that are undervalued or in need of particular encouragement. In carrying out this work, BWF is governed by a Board of Directors composed of distinguished scientists and business leaders, and its competitive award programs are directed by advisory committees composed of leading researchers and educators.

Thus, more than a century after two enterprising American pharmacists set in motion their pioneering partnership, the Burroughs Wellcome Fund remains committed to the belief that fostering research by the best and brightest scientists offers the fullest promise for improving human health today and in the new millennium.

Message from the President

Enriqueta C. Bond, Ph.D.

The mission of the Burroughs Wellcome Fund is to advance the medical sciences by supporting research and other scientific and educational activities. Within this broad mandate, we place primary emphasis on basic biomedical science—research aimed at discovering fundamental knowledge that will underpin broader efforts to improve human health and well-being. To carry out our mission, BWF's general strategy is to support the development of promising U.S. and Canadian scientists early in their careers and to support investigators working in or entering areas of science that are undervalued or underfunded.

With this thumbnail sketch in mind, I would beg the reader's permission to paint a broader-brush picture of what BWF hopes to accomplish. I'm inspired by a book published in 1998 by Dr. Edward O. Wilson, of Harvard University, who is one of the great science philosophers as well as a brilliant science practitioner. In *Consilience: The Unity of Knowledge*, Dr. Wilson attempts to assemble the many issues of concern to the human species into a unified intellectual framework. To this framework he gives the name "consilience," a term invented by the 19th-century philosopher William Whewell and derived from a Latin word meaning "jumping together." Consilience, Dr. Wilson says, is a "jumping together" of knowledge by the linking of facts and fact-based theory across disciplines to create a common groundwork of explanation. He goes on to posit that science, which holds the values of consilience at its very core, may provide a unified basis for ethics, religion, art, and the regulation of human society.

While such ambitions are far beyond the scope of BWF's activities, we are attempting our own efforts at consilience. First, of course, BWF through our various competitive award programs strives to support individuals who will bring new approaches and novel ideas to their scientific fields. By thinking outside the proverbial box, these researchers, it is hoped, will be singularly adept at making knowledge "jump" in exciting ways. Similarly, BWF provides awards targeted at enabling clinician scientists to shuttle creatively between the laboratory bench and the patient's bedside, as well as awards intended to encourage academic institutions to broaden the training of advanced students in physics, chemistry, and mathematics so they can bring their quantitative and theoretical skills to the biological arena. (BWF's Interfaces between the Physical/Chemical/Computational Sciences and the Biological Sciences program is featured in the article beginning on page 20.) The spirit of consilience also is reflected in BWF's desire to foster links between academe and industry across all of our award programs. This focus not only is a fitting legacy for an organization that began life as a corporate foundation; it also is necessary in order to reap the benefits of new scientific knowledge. In addition, BWF complements our competitive award programs by bringing together—consilience, yet again—people and institutions around common problems in the medical sciences.

In this president's message, I hope to illustrate how consilience has proved manifest in some of the key events during BWF's 1998 fiscal year. In the next section, Martha Peck, BWF's vice president for programs, will provide the detailed brush strokes that will bring our various programs and activities to life.

Philanthropy's Role in Strengthening Health Research

BWF continues to believe that philanthropies have an important role to play in advocating for improvements in the environment for research. Thus, it is imperative to develop a more strategic vision of how private-sector funders can partner or work synergistically with the public sector, as well as with industry, to benefit the advance of medical science. I remember a conversation with Carolyn Asbury (at the time, director of the Health and Human Services Program at the Pew Charitable Trusts), who lamented the lack of a meeting ground for private-sector funders of medical research. Together, we recruited the American Cancer Society and the Howard Hughes Medical Institute (HHMI) to partner with our organizations in hosting a meeting that would help fill this missing bit of philanthropic landscape.

Titled "Strengthening Health Research in America: Philanthropy's Role," the meeting was held on February 22-24, 1998, at the HHMI campus in Chevy Chase, Maryland. The meeting was unique in that it drew together leaders from a variety of private foundations, voluntary health organizations, and medical research organizations, as well as leaders from government and industry. It also was one of the first forums of its kind to give philanthropic organizations the chance to exchange ideas on what needs to be done to stabilize and strengthen the health research enterprise. Representatives from approximately 100 organizations attended. Participants agreed that U.S. leadership in medical research and training is under pressure and that the private sector needs to respond in new ways. (A full report of this meeting is available on the Pew Charitable Trusts' website at http://www.pewtrusts.com.) Among the themes that emerged were the following:

Philanthropies have an important role to play in advocating for improvements in the environment for research.

- The environment for health research is changing rapidly at academic health centers, in industry, and in managed care organizations. In response, our structures and systems for training physicians and Ph.D.s need to change as well. At the same time, changes in the health care system and advances in technology are creating new research opportunities. Some promising areas include genomics (the study of the entire human genetic blueprint); neuroscience; interfaces in science, such as the interfaces between mathematics and biology or between physics and biology; and biomedical ethics. Since these fields are young, scientists can run into difficulty securing funding for this kind of work.

- Private organizations may be able to increase their impact by funding "higher risk" or politically unpopular research. Areas identified as ripe for opportunity include reproductive health, substance abuse, and international health and disease.

- Translational and clinical research—the kind of work that speeds results from the laboratory to the bedside—have been hit especially hard in recent years. The private funding community may be able to help ease this situation by devoting greater resources to the clinical research spectrum, including patient-oriented research, epidemiological studies, and outcomes and health-services research.

- Private organizations should increase their support of behavioral research, which is essential for preventing and treating disease.

- Public understanding of science—from encouraging young children to pursue science-based careers to helping adults grasp the importance of research—is critically important.

- Foundations, voluntary health organizations, and research organizations need regular opportunities to exchange ideas and clarify their roles in this important sector. The community lacks an umbrella organization, such as the Council of Foundations, that can serve as a forum for the discussion of such issues. As a start, many participants urged that a follow-up meeting be planned to continue the dialogue on the issues raised and possibly to move forward with definite plans.

Meeting participants agreed that, in light of the dramatic market changes that have taken place in the health care industry in the past several years, major changes need to take place in the training of scientists. Young researchers are finding it increasingly difficult to move beyond the postdoctoral stage, with some researchers remaining at this level for 10 years or more. The conferees noted that although the budget of the National Institutes of Health (NIH) is higher than ever, research dollars and traditional positions in academe have become scarce as more people compete for resources. Greater effort is needed, therefore, to inform students about emerging career opportunities and the training required to pursue them. The participants called for creative thinking about new career pathways that are not limited to academe or industry, as well as about new career paths within the academic community.

Although the budget of the National Institutes of Health is higher than ever, research dollars and traditional positions in academe have become scarce as more people compete for resources.

Under the umbrella of structures and strategies for training, participants cited the need for better systems of mentoring. They also called for establishment of multidisciplinary training that would shift from the "silo" phenomenon (where, for example, physicians train only with physicians) toward organizational structures that promote exposure to a breadth of knowledge (where, for example, behavioral scientists would gain excellent backgrounds in genetics and epidemiology), and they envisioned the creation of multiple career pathways within every degree program.

On the research side, clinical research was singled out for particular attention, as the new health care environment so focused on reducing costs is creating growing strain. Clinician scientists who once combined clinical care with research studies now must spend more time treating patients. The existing system makes it difficult for many M.D.s to compete with Ph.D.s for research dollars. Between 1994 and 1996, the number of M.D.s applying for NIH grants declined by 30 percent. Thus, clinician scientists are facing an "either/or" choice between clinical practice and research, even though their special strength is to combine the insights of both approaches. Participants at the meeting discussed ways of strengthening clinical research and heard from NIH Director Dr. Harold Varmus about new NIH initiatives to address the problem. But participants agreed that the need remains critical for additional resources for translational and biobehavioral research.

This meeting, I believe, identified clear target areas for private-sector support. At BWF, what we heard only helped to reinforce our current program plan, in which our awards support scientists early in their careers and give them the opportunity to innovate and take risks. Most of our programs also attempt to facilitate interdisciplinary work—a theme struck loudly and frequently at the meeting. Our Clinical Scientist Awards in Translational Research specifically target an area identified by meeting participants as badly in need of support. Other BWF award programs support research on diseases that have major impact on people and societies beyond U.S. borders, as well as research in areas, such as reproductive science, that are fraught with political controversy.

I also should point out that, since the meeting, other evidence has emerged suggesting that BWF is charting a promising scientific course. Of particular note, the National Institutes of Health has announced general plans for managing the $2 billion boost it will receive from the federal government in fiscal 1999. The areas highlighted include reinvigorating clinical research; harnessing the expertise of such allied disciplines as chemistry, physics, mathematics, and engineering; exploiting the fruits of genetics research; and reducing health disparities, both in the United States and in other countries. These areas, in large measure, mark the very "terrain" that BWF mapped several years ago as being in need of—and ready for—intensified exploration.

BWF also heard the desire of meeting participants to continue to pull this sector together, and we are working on new initiatives to do so. First, we are helping to organize meetings concerning the plight of young investigators and meetings related to the behavioral sciences. The training of young scientists and their career paths are matters of special concern to BWF, since so much of our program is invested in fostering the "human capital" of the research enterprise. BWF also is hopeful of finding a proper institutional haven for a continuing forum on health research, and we already have established a "listserv" that provides electronic links for the community of private funders. The service enables users to ask questions, share the latest information, and explore emerging issues. (To participate, send an e-mail message to fundershealth@bwfund.org—type the word "subscribe" in the subject field.)

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Bridging the Developed and Developing Worlds

Research and education in science and medicine are becoming increasingly international in scope. Helping to set the global pace are such factors as the rise of rapid modes of electronic communication, the expanding scientific capacity throughout the world, and the emergence of new scientific problems that span our planet. Often, however, international structures and systems for collaboration are not well designed to support the work of scientists who wish to collaborate on pressing problems. Recognizing this gap, the Wellcome Trust, BWF's sister philanthropy in England and the world's largest medical charity, recently allocated $25 million to support a collaborative effort that will bring together scientists from both developed and developing nations as equal partners in the fight against infectious diseases that plague the tropical developing world. This first-of-its-kind program, which is administered jointly by the Trust and BWF, requires that research teams include scientists from the United States or Canada, the United Kingdom, and the tropical developing nations themselves.

The new Infectious Diseases Initiative was developed following a meeting, convened by the Trust and BWF in Vietnam in May 1998, that brought together some 50 scientists and clinicians from around the world to focus on the infectious diseases of the tropics. Among their topics, participants examined the economic and political realities that affect human health in tropical developing countries, as well as the need for research aimed at lessening the impact of infectious diseases in these regions. Because research on these diseases, especially as they affect people and countries beyond the developed world, often is poorly funded—read "undervalued," in BWF's parlance—this clearly is a proper target for philanthropic effort.

The initiative is intended to help develop the research capacity of tropical developing countries as well as to help reduce the toll that infectious diseases take in these countries. The program targets bacterial, viral, and parasitic diseases, including such diseases as diphtheria, dengue, and typhoid fever. Malaria and HIV infection, although of tantamount global importance, are not a focus of the initiative, as the sponsoring organizations recognize that there are other major international programs supporting collaborative work on these diseases. Most of the initiative's awards will provide on the order of $2 million to $4 million over five years. Applications for the first round of awards were received in early 1999, and funded projects will be designated as early as August 1999. A second round of competition is planned for 1999-2000.

Partnerships may focus on basic, clinical, or health-services research, or on some combination of these approaches. Projects that seek to put research into practice are encouraged. While proposals may originate from any of the geographic areas involved, scientists from developing countries will have to play a pivotal role in the research, and, in most cases, the main research will have to be conducted in tropical locations where infectious diseases are causing significant morbidity and mortality. "This exciting funding opportunity will bring together the firsthand knowledge and experience of researchers in developing countries and the complementary expertise of U.K. and North American researchers in both laboratory and long-term field studies," according to Dr. Richard Lane, program director for the Wellcome Trust's Tropical Initiatives. "It will offer new scope for researchers to tackle some of these very persistent health problems." It is increasingly clear that forming global partnerships, effectively multiplying the strengths of each of the participants, is a key step toward reducing the health toll of infectious diseases in the tropics. Moreover, given the potential of these diseases to spread beyond national boundaries, working now to understand the diseases themselves as well as the economic, social, and public health conditions that let them thrive may prove an important investment in the long-term health of the world.

Forming global partnerships that effectively multiply the strengths of each participant is a key step toward reducing the health toll of infectious diseases in the tropics.

Help for Endangered Clinician Scientists

The field of clinical research is under strain, as noted by participants at the "Strengthening Health Research" meeting, as well as by other observers. For example, a recent report by a special NIH Director's Panel on Clinical Research, chaired by Dr. David Nathan, of Harvard Medical School, devised a three-part definition of clinical research. The first part involves patient-oriented research: studies conducted with human subjects (or with material of human origin, such as tissues) by investigators who directly interact with the human subjects. This area includes mechanisms of human disease, therapeutic interventions, and clinical trials. The second part involves epidemiological and behavioral studies, and the third part involves what's known as outcomes research and health-services research. Using this broad definition, the panel found that clinical research garners only about 38 percent of all federal funding for biomedical research.

The rapid growth of managed care has meant that many academic medical centers, which historically have been at the forefront of both basic and clinical research, have seen declining sources of revenue to support research. Two studies published in the *Journal of the American Medical Association* on July 16, 1997, document this troubling trend. One study examined the growth in grants that NIH made to 115 medical schools for clinical and basic research. From 1986 to 1990, the number of grants grew at about the same pace for all medical schools. But from 1991 through 1995, grants grew more slowly among the 13 medical schools that faced the most competition for patients from health maintenance organizations. The second study showed that medical school faculty members in highly competitive health care markets are publishing fewer articles in peer-reviewed journals. In an accompanying editorial, Dr. Kenneth Shine, president of the Institute of Medicine, stated that he believes faculty members are being forced to cut the amount of time they spend on research.

At the "Strengthening Health Research" meeting, Nobel laureate Dr. Joseph L. Goldstein, of the University of Texas Southwestern Medical Center-Dallas, remarked that the clinician scientists most needed are those who carry out patient-oriented research. He predicted that, in addition to their roles at medical and educational institutions, such clinician scientists will be prized by the biotechnology industry in order to translate the molecular revolution in biology into patient products. Investigators involved in patient-oriented research, Dr. Goldstein said, have four "P's" in common —passion, patience, patients, and poverty. Especially because clinician scientists are finding it increasingly hard to get NIH support, they are excellent targets for private sector support.

At BWF, we like to call such patient-oriented research "translational" research—the two-way transfer between work at the laboratory bench and treatment of patients. This year, we made 10 Clinical Scientist Awards in Translational Research, each providing $750,000 over five years. The awards are intended to give recipients the freedom to explore fundamental scientific questions, to apply the resulting knowledge at the bedside, and to bring insights from the clinic back to the laboratory for further exploration. In this way, BWF hopes to catalyze the development of a cadre of experienced clinician scientists positioned both to bridge the gap between the bench and bedside and to train the next generation of investigators in translational research. Let's call it our version of consilience in linking basic research with clinical research.

BWF hopes to catalyze the development of experienced clinician scientists who can bridge the gap between the bench and bedside and train the next generation of investigators in translational research.

In addition to our award programs, BWF is supporting clinical research in other ways as well. In the same issue of *JAMA* cited above, James Thompson and Jay Moskowitz, both of Wake Forest University School of Medicine, called for the American Medical Association and the Association of American Medical Colleges (AAMC) to host a "National Clinical Research Summit." The summit, they proposed, should bring together all of the players in the clinical research enterprise to set a mutually shared agenda for the 21st century. Accepting this challenge, BWF this year made a grant to AAMC to help support the summit, which to date has consisted of a series of focus groups and a retreat held in November 1998.

Forging Ties between Academe and Industry

Although he may never have used the term "consilience," Dr. Lewis Branscomb, a respected science observer who for years worked in industry and now is at Harvard University's Kennedy School of Government, long has proselytized for stronger interactions between academe and industry. Strong and dependable federal support for a broad spectrum of academic research is a major factor in making our universities ideal places for industrial collaboration. On the other hand, he argues, since private investment in a competitive marketplace is the best means for allocating the scientific and engineering resources of industry, it is appropriate that government leave to industry the task of exploiting the knowledge base created by our universities. The more effectively industry carries out this task, the greater the economic leverage of our public investment in university research. Further, exposing professors and students to the ways of industry not only helps prepare young scientists and engineers to assume careers and technical leadership in industry; it also helps ensure that academic researchers will be aware of and pursue industrially relevant areas of investigation.

Dr. Ralph Snyderman, chancellor for health affairs at Duke University Medical Center, has sounded the same theme. First, he says, biotechnology and molecular biology are changing the practice of medicine in ways that we can only begin to imagine. Second, research partnerships between academic medical centers and private industry are playing a critically important role in making these advances a reality. The promising therapies now emerging represent the culmination of decades of basic research that is being translated into practical application with the help of industry. Dr. Snyderman concludes that academic-industry partnerships are essential to this process of translating research discoveries into new and better treatments.

Indeed, many universities already are fostering the transfer of knowledge into economic benefit through alliances with industry. In 1997, for example, the top U.S. research universities earned a total of more than $446 million from licenses on their inventions and were awarded 2,239 new patents, according to a recent survey by the Association of University Technology Managers. The survey also showed that research at universities spawned 258 new companies based on licenses to the resulting inventions. Similarly, Dr. David Blumenthal, of Harvard University, who is an expert on academic-industry relationships, has reported that 90 percent of U.S. companies conducting life-science research in 1994 had research relationships involving an academic institution. Fifty-nine percent of these companies provided funds to support research in such institutions, providing an estimated $1.5 billion, or approximately 11.7 percent of all research-and-development funding received that year. Nor is this interest limited to the United States. In Canada, for example, both the Natural Science and Engineering Research Council and the Medical Research Council have developed new programs to promote university-industry collaborations.

Promising therapies now emerging represent the culmination of decades of basic research that is being translated into practical application with the help of industry.

In forging university-industry collaborations, of course, there are concerns about the propriety of such relationships and questions about how best to manage them. On many campuses, researchers, particularly in biotechnology, are pursuing corporate support avidly while simultaneously worrying about the ethical dilemma that arises as they surrender a certain amount of academic freedom in the bargain. Such questions must continue to be addressed, but BWF believes that open and positive considerations of these issues will lead to increasing—and increasingly effective—examples of consilience at work.

For BWF's part, we have begun a process of convening our awardees (a different group each year) to provide networking opportunities, to solicit advice about our award programs, and to present information pertaining to career development. In July 1998, we convened the recipients of BWF's four new investigator award programs. Knowing that academic-industry collaborations are of growing interest to young scientists, we surveyed the participants to gain insight into their questions and concerns. Four areas emerged: 1) How do you get started in setting up interactions with industry? 2) How do you address issues involving intellectual property, such as who can publish scientific findings, and when? 3) What can you expect from your industrial partner, and what will that partner expect from you? 4) How do you address "the intangibles"—the more philosophical questions about the interplay of commerce, education, and the health of the public?

At the meeting, four leaders in science and industry were on hand for a panel discussion. The panelists included Philip R. Tracy, former president and chief executive officer of Burroughs Wellcome Co.; Dr. David Barry, former vice president for research, development, and medical affairs of Burroughs Wellcome Co., who now is leading his own start-up company, Triangle Pharmaceuticals; Dr. Steven Michnick, a BWF new investigator in pharmacology who both collaborates with industry and is starting a biotechnology company; and Dr. John DesRosier, director of the University of Washington's Industry Relations Office. Their discussions made it clear that scientists at universities and in industry can interact in a variety of ways. The possibilities range from relatively limited collaborations, such as sharing reagents and providing access to equipment, to more complex arrangements that involve such things as the industrial support of academic research or the forging of formal agreements between a company and a university (one such example cited being a partnership formed between the University of Washington and Monsanto). Most interactions arise from contacts developed between individual scientists, and, in a not always appreciated note of economic reality, most industrial grants are fairly modest, averaging about $50,000.

As collaboration between academe and industry becomes more pervasive, it becomes increasingly essential that scientists learn how to manage these arrangements successfully.

The panelists underscored the different perspectives of industry and academe, as well as the need to be aware of the characteristics of each camp in forging relationships. Alliances bear both benefits and risks, they said, which means that careful management will be required to produce the best outcome. Benefits include additional support of academic research, extra income for academic health centers, and the potential for increased scientific and commercial productivity in both industries and universities. Risks include a potential increase in secrecy in academic environments, a shift in scientific focus that might concern young scientists seeking tenure, and distraction from primary research interests in order to meet demands of the industrial partner.

There was consensus that when university scientists are considering entering into an industrial agreement, or even thinking about starting their own company, they should consult with their institution's technology transfer office for guidance on how to manage the process and avoid potential pitfalls. The panelists also identified some "fundamentals" for collaborations. These essentials include defining goals carefully and realistically, clarifying both your expectations and the company's expectations about the collaboration, maintaining good communication channels throughout the collaboration, understanding and reporting situations that hold potential for conflicts of interest, and entering collaborations with the intent of establishing a long-term relationship. As collaboration between academe and industry becomes more pervasive —perhaps even "the way of the future," in some predictions—it becomes increasingly essential that scientists learn how to manage these arrangements successfully.

In the words of Louis Pasteur, the 19th-century French scientist whose work continues to provide immeasurable benefits worldwide: "To him who devotes his life to science, nothing can give more happiness than increasing the number of discoveries, but his cup of joy is full when the results of his studies immediately find practical applications." Surely, university-industry collaborations are an important mechanism for linking together different communities—Dr. Wilson's consilience—in order to reach this "joy" that flows from helping science advance human health and well-being.

Enriqueta C. Bond

Programs

Martha G. Peck
Vice President,
Programs

> *I would submit to you that the activities of foundations and voluntary health agencies have never been more important, because they provide an opportunity where your capacity to innovate, your capacity to model, your capacity to rapidly experiment can help guide the way in which federal money is spent during this expanding period. I believe that you have an opportunity to lead that is unparalleled in the past 25 years.*
>
> Kenneth I. Shine, M.D.
> President, Institute of Medicine

Dr. Shine made these comments at a February 1998 meeting of private foundations, voluntary health organizations, and medical research organizations, titled "Strengthening Health Research in America: Philanthropy's Role." The Burroughs Wellcome Fund sponsored this first-of-its-kind meeting in partnership with the American Cancer Society, the Howard Hughes Medical Institute, and the Pew Charitable Trusts. In her article in this annual report, BWF President Dr. Enriqueta Bond described the meeting and summarized some of the opportunities for private funders in today's dramatically changing environment for health research. It is our hope that this meeting will be a beginning—a first step in engaging private philanthropy in an ongoing effort to identify ways to leverage grant dollars for research that will improve human health. For BWF, the meeting also provided a "measure of confidence" that we have positioned our award programs to meet two areas of critical need—the support of U.S. and Canadian scientists early in their careers and the nurturing of underfunded areas of biomedical research and training.

BWF is only one of an estimated 41,588 foundations in the United States. Total giving of foundations—$13.3 billion, for all purposes—is less than the $15.6 billion fiscal year 1999 budget of the National Institutes of Health, the nation's major supporter of health research. But we realize that size alone does not dictate opportunity. For foundations, the opportunities in health research spring from our ability to convene, to catalyze, to focus upon, to experiment, and to be timely and flexible. As Dr. Shine noted, beyond the mere dollar value of our assets, foundations' real power lies in *how* we use these assets for purposes that government cannot, will not, or has not yet had the opportunity to do.

In fiscal 1998, BWF approved more than $38.9 million in new grants and paid out more than $22.7 million in grants, a payout greater than in any year in our 43-year history. We supported nearly 600 active grants (new and continuing) at more than 200 academic and other nonprofit institutions across the United States and Canada. The vast majority of grants, 87 percent, were awarded through our specially designated competitive award programs. Most grants, 69 percent, went to academic institutions, with awards earmarked for individual scientists who have been nominated by their institutions. Our overall award rate, including both competitive and ad hoc grants, was 33 percent. But the numbers tell only a small part of BWF's story. The *real* story is told in the organizations and individual faces behind our grants—for it is their achievements and progress in advancing biomedical research and science education that help BWF fulfill our mission.

BWF's 1998 awards are summarized in the table below. As the table illustrates, the Fund targets seven major focus areas. Six of the focus areas have one or more competitive award programs designed to fulfill BWF's two-pronged strategy of investing in the career development of scientists and fostering knowledge in targeted research areas. In the seventh focus area, we strive to fulfill a larger role in the science community by advocating for, and supporting activities to help bring about, improvements in the general environment for research. To go beyond the numbers, a more detailed picture of BWF's activities is presented in the sections that follow.

AWARDS APPROVED, BY MAJOR PROGRAM AREA

Career Development of Scientists	$ 16,096,469
Emerging Infectious Diseases	6,705,533
Therapeutic Sciences	10,346,717
Reproductive Science	1,239,000
Interfaces Program	426,500
Science Education	2,677,092
Environment for Science	1,451,962
TOTAL	**$ 38,943,273**

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In fiscal 1998, BWF approved more than $38.9 million in new grants and paid out more than $22.7 million in grants, a payout greater than in any year in our 43-year history.

Career Development of Scientists

In BWF's largest career-development program, 25 postdoctoral researchers received Career Awards in the Biomedical Sciences, with awards totaling $12.8 million. These awards, divided between researchers who hold Ph.D.s and researchers who hold M.D.s (or equivalent degrees), provide "bridging" support to facilitate the critical transition to becoming an independent investigator. Among other efforts, the recipients are analyzing the atomic structure of the protein coat that helps the AIDS virus invade human cells and probing the genetics of the body's natural immune system that guards against threatening microorganisms. Working across a range of disciplines, their research projects share a common goal—discovery of basic knowledge that will underpin broader efforts to improve human health and well-being. In the four years this program has been operating, a total of 77 researchers have received awards. Forty-four recipients, or roughly 57 percent, already have earned academic tenured faculty positions—one of the program's primary goals.

Science is increasingly a global enterprise, and overseas travel programs, BWF believes, provide valuable international research experience. We currently support two such programs. First, Hitchings-Elion Fellowships support two years of postdoctoral training in laboratories in the United Kingdom or the Republic of Ireland, supplemented by a third year in the United States or Canada to either continue training or begin a faculty appointment. Ten awards were made, for a total of $1.5 million, bringing the number of active fellows to 42. In response to fellows' requests for longer support and BWF's recognition that most postdoctoral training requires more time, the Hitchings-Elion program now has been revised to extend the fellowship period to three years (including a transitional year that can be spent either overseas or in the United States or Canada) and to provide two years during the beginning faculty period. This new structure more closely parallels the Career Awards in the

Biomedical Sciences program, which, beginning in 1998, also has been modified to permit postdoctoral training to be undertaken in the United Kingdom or the Republic of Ireland. In the second travel program, BWF Research Travel Grants—formerly known as Wellcome Research Travel Grants—enable biomedical scientists and medical historians to work for up to six months in the United Kingdom or the Republic of Ireland. These grants are intended to help build scientific collaborations and to provide for the timely sharing of new information and techniques. BWF made 51 travel grants, including nine in the history of medicine, averaging $6,500 each.

This year, BWF's Board of Directors put into place an evaluation plan for the Career Awards in the Biomedical Sciences program. Through a partnership with the Commission on Professionals in Science and Technology (CPST), each cohort of awardees will be surveyed regularly during the tenure of their award. Evaluation also will be extended beyond the conclusion of individual awards through follow-up surveys, the convening of focus groups, and citation analyses, with a goal of determining the longer-term impact of the awards in fostering independent, successful research careers. BWF plans to share the information with other groups and government agencies so that, working together, all can carry out their career-development activities in the most effective manner.

Emerging Infectious Diseases

Within the broad area of emerging infectious diseases, BWF targets human diseases caused by parasites and pathogenic fungi. Infectious diseases are on the increase worldwide, for several reasons—the emergence of resistant organisms, which limits the availability of effective agents for disease prevention and treatment; the increase in populations living in the tropical developing world, where these diseases are most prevalent; and the increase in the number of persons whose immune systems have been weakened by diseases, such as AIDS, or by certain medical treatments, such as cancer therapy.

BWF hopes to bring new thinking and innovative research approaches to the study of human diseases caused by parasites and pathogenic fungi.

BWF made seven scholar awards and nine new investigator awards in molecular parasitology and mycology, for a total of approximately $4.6 million. By supporting a cadre of early-career and mid-career investigators, we hope to bring new thinking and innovative research approaches to these underfunded areas of science. The award recipients are undertaking projects across a broad spectrum. One scholar in molecular parasitology, for example, is exploring the functions of a recently identified structure, or organelle, located within the cells of numerous parasites, in hope that this site will prove attractive as a target for drug therapy. In mycology, one new investigator is working to identify new genes in a fungal pathogen that often afflicts AIDS patients as their immune systems are suppressed. In addition, a special initiative to foster more research into the pathogenesis and treatment of malaria provided five awards totaling almost $1 million. Complementing these award programs, BWF also has continued to support a variety of training efforts to draw more people into the fields of parasitology and medical mycology and to strengthen the network of researchers in these fields. Of particular note, BWF provided $600,000 to renew our commitment to the "Biology of Parasitism" training course, held at the Marine Biological Laboratory, in Woods Hole, Massachusetts. This annual course—along with a sister "Molecular Mycology" course—provides advanced graduate students, postdoctoral fellows, and independent investigators with state-of-the-art training in the molecular analysis of parasitic and fungal pathogens that infect humans.

In recognition of the major importance of malaria worldwide—it claims more than 2 million lives each year—BWF has been participating in several international activities to combat this disease. We provided more than $1 million in continuing support of the project, under way since 1996, to sequence the genome (the complete set of genetic material) of *Plasmodium falciparum,* the causative agent of malaria. Three of the organism's 14 chromosomes have been or are about to be completed, and work on the remaining chromosomes is progressing steadily. The consortium of funders, which includes BWF, the Wellcome Trust, the National Institutes of Health, and the U.S. Department of Defense, has established three task forces to consider issues relating to the development of a centralized database, the utilization of DNA array technologies that will allow fast systematic analysis of gene expression, and the improvement of genetic tools for studying malaria. In other international activities, BWF has been involved in the Multinational Initiative in Malaria, which focuses on African nations, where the disease kills one in three children under the age of five, and in the Medicines for Malaria Venture, a proposed public-private partnership to discover and develop new antimalarial agents.

Therapeutic Sciences

BWF currently supports two programs in the therapeutic sciences—New Investigator Awards in the Pharmacological or Toxicological Sciences and, our newest program, Clinical Scientist Awards in Translational Research. These programs share a common theme of seeking to advance our knowledge of human health by acquiring more information on the effects of drugs and xenobiotics (foreign substances, such as environmental chemicals) at the molecular, cellular, and organ levels, as well as their effects on entire organisms, including humans and animals. The goal is to translate information derived from both the laboratory and the clinical setting to improve health.

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Ten new investigator awards were made, six in the pharmacological sciences and four in the toxicological sciences, for a total of almost $2 million. The awards support individuals who are in the first three years of a faculty appointment. Recipients have considerable flexibility in their research activities, as both pharmacology and toxicology encompass broad areas. In pharmacology, for example, one awardee is using genetic and molecular tools to investigate, in certain parasitic worms, a key biological signaling pathway that, in humans, can lead to cancer when it goes awry. In toxicology, one investigator is using biophysical methods to probe the mechanisms by which lead causes its damage at the molecular level, perhaps ultimately leading to the development of new sensors and therapeutic agents that are particularly specific to this environmental toxin.

BWF made 10 awards in translational research, offered for the first time in 1998, totaling $7.5 million. The awards support clinician scientists who are at the associate professor level or equivalent, and they are intended not only to "protect" awardees' time for research, but also to provide them with time to serve as mentors for the next generation of clinician scientists. The program's aim is to support the two-way transfer between work at the laboratory bench and treatment of patients. This "translation" of knowledge derived from basic research into greater understanding of the natural history of disease, improved clinical knowledge, and better diagnosis and management of medical maladies is critical. But this process is under stress, as a result of changes in the health care system that have reduced revenues and patient populations at academic health centers, which traditionally have been at the forefront of basic and clinical research.

We also were involved in several activities in the therapeutic sciences that reach beyond the competitive award programs. BWF provided support for a timely "National Clinical Research Summit," convened by the Association of American Medical Colleges and the American Medical Association to examine the clinical research enterprise from the perspectives of a variety of stakeholders and to propose a strategy for ensuring its future support. In addition, we connected to professional and scientific organizations in pharmacology, toxicology, and medical research by sponsoring plenary lectures at the annual meetings of the Society of Toxicology and the American Society of Pharmacology and Experimental Therapeutics, and by providing support for young scientists to attend a national meeting of the American Federation for Medical Research.

Reproductive Science

BWF considers reproductive science to be seriously underfunded and understudied. Although our awards in reproductive science represent a modest share of BWF's grantmaking, we nonetheless believe that work by our awardees is helping extend knowledge in this crucial scientific area. BWF targets at least one of our Career Awards in the Biomedical Sciences to this field, and this year awards went to two researchers in reproductive science—one of them studying the complications that diabetes causes during pregnancy and the other studying the role of the hormone estrogen and its intracellular receptor in the regulation of gene activity during human growth and development.

In addition, BWF made our first award through the Reproductive Scientist Development Program (RSDP), which helps U.S. obstetrician-gynecologists working in the basic reproductive sciences bridge the postdoctoral years and initial faculty years. RSDP is a consortium supported by the National Institute of Child Health and Human Development, professional societies, and foundations. RSDP supports an awardee's postdoctoral years, and BWF provides support for the first three faculty years. BWF also continued, in partnership with the American Association of Obstetricians and Gynecologists Foundation, a postdoctoral research fellowship in obstetrics and gynecology.

Some of the most promising research in biomedicine is being done by investigators with strong backgrounds in physics, chemistry, and mathematics.

Beyond these competitive award programs, BWF catalyzed the development and successful launch of the first "Frontiers in Reproduction" course, held in spring 1998 at the Marine Biological Laboratory. This is a hands-on, laboratory-based, career-development course designed to teach participants state-of-the-art research technologies and to help them develop molecular and cellular research concepts and applications in reproductive science. The keen competition for enrollment ensured that the 16 course participants—from the United States and nine other countries—represented some of the most promising young physicians and Ph.D. scientists entering the field. The course achieved excellent reviews and is next scheduled for spring 1999.

Interfaces between the Physical and Biological Sciences

In 1996, BWF launched a new award program to encourage the interdisciplinary training of promising graduate and postdoctoral students from the physical, chemical, and computational sciences so that they might bring their quantitative and theoretical approaches to the biological arena. These institutional awards, made for the first time in 1997 and offered every other year, are aimed at breaking down traditional departmental structures and barriers that often impede the cross-training of students. The program highlights the growing recognition that some of the most promising research in biomedicine—for example, the use of functional magnetic resonance imaging to see where information is processed in the brain—is being done by investigators with strong backgrounds in physics, chemistry, and mathematics.

Although this was an "out year" for the awards, BWF took this opportunity to convene for the first time the program directors and BWF-supported graduate and postdoctoral students who are involved in the first cadre of awardees. The "Doing Science at the Interface" workshop had several aims—to explore relevant science topics (such as protein folding and the kinetics of the genetic material DNA) through posters and presentations, and to discuss career opportunities and the challenges of interdisciplinary training. The meeting also continued BWF's efforts to "bring our family together" in ways that promote a spirit of collegiality. A summary report on the workshop is adapted in the article beginning on page 20. As a measure of the workshop's success, participants felt it was so useful that they proposed another convocation in January 2000 on "Quantitative Challenges in the Post Genomic Sequence Era." Indeed, one of the BWF-funded programs—the La Jolla Interfaces in Science Training Program, which is administered by the University of California-San Diego, and also involves the Scripps Research Institute, the Salk Institute for Biological Research, and the San Diego Supercomputing Center—already has taken the lead in developing the workshop.

Although the 1999 interfaces awards properly fall in BWF's current fiscal year, it seems appropriate to present a "sneak preview" of the two awards, totaling $4.8 million, that were announced recently. Brown University will use its award to develop a Brain Science Interface Program, an interdisciplinary training effort incorporating theoretical, analytical, and computational approaches to understand the large-scale phenomena that emerge from nerve cells. Faculty from applied mathematics, computer science, physics, neuroscience, and cognitive and linguistic sciences form the core of this program. Johns Hopkins University will use its award to build a training program around advanced methods in computational biology. In addition to course work, students will receive industry exposure by completing a three-month internship at the Institute for Genomic Research, known as TIGR, which is a not-for-profit organization devoted to analyzing genomes and gene products in a variety of organisms, including humans.

BWF believes that the best way to get students involved in science is through hands-on, engaging activities that let students "do" science.

Science Education

A cornerstone of BWF's efforts in science education is the Student Science Enrichment Program (SSEP), which targets middle school and high school students in the Fund's home state of North Carolina. With a guiding principle that "the best way to get students involved in science is through hands-on, engaging activity," the SSEP was launched in 1996. The goal: to expand students' competence in science, nurture their enthusiasm, and interest them in pursuing careers in research or other science-related areas. How is this accomplished? Briefly, SSEP activities provide experiences that let students "do" science—experiences that are exciting, that offer insight into the investigative process, and that connect science to students' daily lives. BWF made eight SSEP awards this year, bringing the number of current awards to 28; approximately 14,000 students have participated. Most programs are based outside of the usual school environment, with universities, museums, community organizations, and other nonprofit groups taking lead roles. New partnerships also have been forged between universities and such groups as the North Carolina chapters of the American Heart Association and the American Chemical Society. To share our experiences more broadly, BWF in July 1998 released a summary report titled *Making Science and Mathematics Real for Kids*. This report, which grew from a meeting of program directors as well from ongoing program evaluations being conducted by a team of outside consultants, is adapted in the article beginning on page 27.

Another component of BWF's science education efforts is the support of visiting professorships at degree-granting institutions in the United States and Canada. This year, 43 colleges and universities received awards that enabled them to bring distinguished scientists to their campuses to spend time interacting with students and faculty and to deliver special Wellcome Lectures—now renamed BWF lectures—on a topic related to their disciplines. The visiting professorships, which are awarded on a competitive basis, encompass fields in both the basic medical sciences and the microbiological sciences. The professorships often prove especially valuable to institutions with predominantly minority enrollments, smaller institutions, newer institutions, and those located in less urban areas.

In other efforts, BWF continued its support of science education in North Carolina through ongoing ad hoc grants to the Education Future Center, based at the North Carolina School of Science and Mathematics, and to the newly formed Institute for Educational Policymakers, which operates under the aegis of the North Carolina Public School Forum. The Education Future Center includes seven "cyber campuses," strategically located across the state, that are devoted to expanding distance learning capabilities and connecting students and teachers with educational resources in science and mathematics. An initial BWF seed grant to the center has leveraged additional support totaling $17 million from state, federal, and other private sources. The Institute for Educational Policymakers—the first of its kind and considered a model for the nation—is devoted to enhancing the educational policymaking capacity of elected state and local officials by providing them with timely, factual, and unbiased information on education, and particularly information related to science and technology. The institute has held a series of forums and briefing sessions for members of the North Carolina legislature and the Board of Education, as well as for members of selected media, covering such topics as the history of education reform efforts in the state, lessons learned from other states, and fiscal accountability. These efforts, it is hoped, will help inform public discussion and decision making in matters of such vital importance to education.

Planning efforts focus on engaging a broader group of foundations and voluntary health associations in exploring new ways of supporting health research.

Environment for Science

Among BWF's various activities this year to foster improvements in the general environment for science, several efforts stand out. For the first time, BWF convened all of our new investigators from four fields—pharmacology, toxicology, parasitology, and mycology—at a two-day meeting intended to highlight the awardees' work and to promote scientific collaboration. The meeting was designed to provide participants with ample opportunity to network, to learn more about each other's fields, and to interact with senior scientists from BWF's advisory committees and board. The meeting also focused on helping the awardees with various career-development issues; included, for example, was a session on academic-industry collaborations and a roundtable discussion on the myriad issues, such as laboratory management, that invariably seem to complicate the lives of new faculty.

Another achievement stems from the success of the February 1998 "Strengthening Health Research" meeting. Hearing participants call for some type of forum to "stay connected," BWF has established an electronic "listserv" to provide an ongoing means for the attendees—as well as other groups—to seek and share information. We also have helped form planning groups around two issues that emerged from the meeting: the training of research and clinical scientists, and bridging the gap between the biomedical and behavioral sciences. Both planning efforts focus on how to engage a broader group of foundations and voluntary health associations in exploring new ways of supporting health-related research so that, working together, the philanthropic community can best bring our strengths to bear on improving human well-being.

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As a result of work by BWF's awardees, coupled, of course, with the efforts of their many colleagues across North America and beyond, new knowledge about health and disease is increasing—exponentially, in many fields. The challenge is both to build on our current strengths and to find innovative ways to foster the development of researchers, always keeping in mind the ultimate goal of applying the fruits of scientific discovery to the improvement of human health. Private philanthropy, as Dr. Shine reminds us, has a critical role to play and must seek out new ways to apply its resources, to work in collaboration with other funders, and to fill gaps left by traditional funding sources. Failing to respond will mean missing a time of great need, and of great opportunity.

The challenge is both to build on our current strengths and to find innovative ways to foster the development of researchers.

Doing Science at the Interface

Recent scientific advances make it possible to analyze complex biological phenomena, including disease processes, in terms of basic physical and chemical interactions of molecules. Indeed, some of the most promising discoveries in biomedicine have resulted from the insights of investigators with strong backgrounds in physics, chemistry, and mathematics. Examples of such interdisciplinary research include the use of a process called x-ray diffraction to analyze the interactions between drugs and the body's cells and the use of mathematical techniques to analyze the incredibly complex human genetic blueprint for biologically meaningful information.

Yet at many of the institutions that are training today's—and tomorrow's—scientists, strong organizational barriers often impede efforts to bring students with training focused in the physical, chemical, or quantitative sciences into graduate and postdoctoral programs in the biomedical sciences. Even when the necessary infrastructure for providing such interdisciplinary training is in place, institutions need to be motivated to bring their units together, to lower barriers for interdisciplinary research, and to develop specialized curriculum and training programs.

In 1996, the Burroughs Wellcome Fund launched a new initiative to help remedy this situation—a program called Interfaces between the Physical/Chemical/Computational Sciences and the Biological Sciences. In the first round of awards, BWF named four recipients, with each receiving approximately $2.5 million over five years. Two universities received awards: the California Institute of Technology and Rockefeller University. The other two awards went to consortiums: the La Jolla Interfaces in Science Training Program (administered by the University of California-San Diego, and also involving the Scripps Research Institute, the Salk Institute for Biological Research, and the San Diego Supercomputing Center) and the Program in Mathematics and Molecular Biology (administered by Florida State University, and also involving 11 other institutions nationwide). In 1998, BWF announced the second round of awards, which went to Brown University and Johns Hopkins University. (Information about these programs is available on their websites; the addresses are listed at the end of this section.)

BWF's interfaces awards are intended to fill the gap left by federal funding efforts that are predominantly built around specific disciplines, and the Fund believes this is the only private program devoted to bridging the physical and biological sciences through institutional interdisciplinary training grants. The program, it should be noted, is not meant to introduce more graduate and postdoctoral students into the research system, but rather to promote a different kind of training and a change in institutional behavior. Emphasis is placed on supporting new programs or existing programs that will change graduate and postdoctoral training in a meaningful way, as opposed to programs seeking more funding for conventional activities already under way.

To further encourage collaborations across disciplines, BWF in June 1998 convened its first workshop, titled "Doing Science at the Interface," to focus on the discoveries, opportunities, and difficulties of interdisciplinary science. The workshop—held at the University of California-Berkeley, one of the institutions involved in the Program in Mathematics and Molecular Biology—brought together participants in the first cadre of BWF interfaces awardees. The 146 participants ranged from undergraduates to full professors, although the majority were graduate students. The range of academic backgrounds was unusually diverse for a scientific meeting of this size: included were sizeable contingents of mathematicians, biologists, chemists, and physicists. While the levels of experience varied, all participants shared a belief that future progress in biology and medicine will require scientists who have skills that cross traditional boundaries between disciplines.

Knowledge Jumping Together

This overarching theme of consilience, or "jumping together" of knowledge from different disciplines, was articulated in the workshop's keynote lecture, delivered by Tamar Schlick, Ph.D., a member of BWF's interfaces program advisory committee. Dr. Schlick is a professor of chemistry, mathematics, and computer sciences in the Department of Chemistry and the Courant Institute of Mathematical Sciences, as well as a Howard Hughes Medical Institute Investigator, at New York University. She discussed consilience in the context of the biomolecular revolution, beginning by explaining the concept of mathematical modeling and then describing how this approach is used to analyze the structural dynamics of the human genome. The human genome, which consists of 3 billion individual coding units packaged within 23 pairs of chromosomes, carries all of the information required for operation of the body's cells and for determining what traits are passed from generation to generation.

Future progress in biology and medicine will require scientists who have skills that cross traditional boundaries between disciplines.

The workshop afforded representatives of each program the chance to present the results of their research—and, incidentally, to do a little recruiting. At two poster sessions, nearly 50 graduate and postdoctoral students presented their research. Two open discussions, one in panel format and the other in a small-group format, focused on career issues and on ways BWF might continue promoting interdisciplinary research. Many of the attendees also took part in a concurrently running short course sponsored by the Program in Mathematics and Molecular Biology, which codirector DeWitt L. Sumners, Ph.D., a Distinguished Research Professor in the Department of Mathematics at Florida State University, called a "substrate" for the BWF workshop. The short course enabled students with a background in mathematics, statistics, or computation to appreciate the real-life complexities of biology that don't always lend themselves to clean mathematical models. In addition to the scheduled events, the workshop also afforded ample opportunity for attendees to interact more informally at an evening banquet and during other free-time activities designed to have a high "mingle" quotient.

The key role of interdisciplinary training perhaps is nowhere more evident than in the hot new field of "bioinformatics"—the study of how information is represented and transmitted in biological systems—which was the subject of considerable discussion at the workshop. A century and a half after the Gold Rush, biologists are facing an information rush: the explosion of data emerging from such sources as the Human Genome Project and the Protein Data Bank. The contemporary equivalents of the forty-niners are the specialists in other disciplines who are helping biologists understand and "mine" this information.

Indeed, prospects for employment in industry for specialists in bioinformatics could hardly be brighter, to judge from the comments of the two bioinformatics department heads who spoke at the panel discussion on careers. "We're desperately looking for good people," said David Balaban, Ph.D., director of bioinformatics and information systems at Affymetrix Inc., a company that manufactures DNA chips. DNA chips are, put simply, miniaturized, high-density arrays of "genetic probes" that are useful in gene typing and monitoring gene expression. Polly Moore, Ph.D., vice president of information resources at Genentech, sounded an equally optimistic note for job hunters. "Right now and for the foreseeable future, the combination of biology, computational science, and math skills is the ticket to anywhere you want to go," Dr. Moore said. "So if you accidentally choose a company that doesn't make it, you are still eminently employable. Everybody's got open positions."

A background in mathematics, Drs. Moore and Balaban said, gives students more than the knowledge of specific results: it instills a talent for analytical thinking. "The real value of mathematics in industry is the ability to organize complex problems in very systematic ways," said Dr. Balaban. Designing a new DNA chip is a good example: engineers at Affymetrix have to figure out where to place hundreds of thousands of DNA sequences on a piece of glass, in order to meet customers' requirements. The process of designing a new chip is complex enough to "brown out" the company's computing capacity for two days at a time—yet the company typically has to do it 10 times a month. Clearly, specialists who can solve such problems quickly are valuable to Affymetrix. Said Dr. Balaban: "I want people who can look at a hard problem, take charge of it, and get it done."

But even in this time of opportunity, it is not obvious how budding scientists should start a career in bioinformatics or other interdisciplinary fields. The workshop opened a significant debate over the question of whether training in two subjects is actually the right way for graduate students to prepare for an interdisciplinary career. To the dismay of some listeners, the experts advised scientists seeking an interdisciplinary career to proceed from a solid foundation in just one subject. The bluntest warnings came from the panel's two academic members. "It's essential to obtain an excellent framework in one discipline," said Dr. Schlick. "You can't be an interdisciplinary person if you don't have that basis. I don't think it's too easy to [combine disciplines] pretenure." David Miller, Ph.D., a visiting scientist at Mount Sinai Medical School, added: "Sooner or later, you're going to have to solve a hard problem. That's hard to do if your training is wide but not very deep."

"Right now and for the foreseeable future, the combination of biology, computational science, and math skills is the ticket to anywhere you want to go."
—Dr. Polly Moore

Such comments provoked many questions from an audience that was mostly predoctoral (not to mention pretenure) and who had already invested a great deal of energy in studying more than one science. Some participants felt the panel had defined the idea of a disciplinary specialty too narrowly. "Nature doesn't make these divisions—why should we?" asked one graduate student. Others felt that there were two conceptions of working at the interface. Some students agreed that it was an unreasonable goal to personally become an expert in two sciences, or to "unify two labs," as some mentors expect. But they argued that one could become expert in one discipline, while studying the language and problems of another field enough to collaborate with specialists in that one. The second approach also seemed consistent with the advice of panelists like Dr. Moore to "keep an open mind, and be flexible about what you want to work on."

Perhaps the most frequent concerns or complaints of the students had to do with the perception held by more traditionally oriented peers or employers regarding the nature of interdisciplinary work: "'What are you good at?' they ask. People don't know," one participant responded. The students also commented on the difficulty of finding appropriate mentors—or balancing two mentors, as some of the programs require. Another topic that aroused considerable interest was the problem of combining parenthood with a career in science. Drs. Schlick and Moore, along with the other panelists, agreed that there is no such thing as a "good" time for a scientist to have children, so those who want them shouldn't wait. Panel moderator Nicholas Cozzarelli, Ph.D., a professor of molecular and cell biology at the University of California-Berkeley, said that taking a maternity or paternity leave for up to a year carries no stigma in academia. He added, however, that a person who chooses to take five or six years off to raise a child would face serious hiring or promotion obstacles at a place like Berkeley.

Folded Proteins and Knotty DNA

The scientific talks at the workshop focused on the inside of the cell, where proteins fold and the genetic material DNA slithers and writhes. José Onuchic, Ph.D., and Charles Brooks, Ph.D., codirectors of the La Jolla Interfaces in Science Training Program, led off by discussing their work on the protein-folding problem: how does a protein with 100 amino acids (the building blocks of proteins), which might have 2^{100} possible shapes to choose from, manage to find its natural folded state in billionths of a second, instead of billions of years? The pair outlined two very different, but mutually reinforcing, approaches to the problem.

"I want people who can look at a hard problem, take charge of it, and get it done." —Dr. David Balaban

Dr. Onuchic compared a protein to a chain of elementary-school children, holding hands in an order decided by the teacher, obeying those time-honored rules: "boys like boys, girls like girls, boys hate girls, girls hate boys." Depending on the order of the students, the line might very quickly fold into a formation where everyone was standing next to a child of the same sex. Or, the line might get trapped in a "frustrated" mode, with some of the boys surrounded by girls. As a physicist, Dr. Onuchic borrowed concepts from thermodynamics to measure the "frustration" and "degree of order" of a protein, and he then made quantitative predictions about the number of correct contacts required for a protein to lock into its native state.

To verify Dr. Onuchic's conceptual model, Dr. Brooks, a chemist, used a supercomputer to simulate the motion of proteins with up to 20,000 atoms, immersed in several million molecules of water. Each "energy landscape" took approximately a month of computing time. For a simple protein with amino acids forming three helical shapes, the "landscape" agreed very well with Dr. Onuchic's predictions, but for the other proteins—one of them shaped like a barrel, the other containing a helix and a sheet—Dr. Onuchic's model did not work as well. Nevertheless, because of the extravagant time required for an atom-by-atom simulation, simple conceptual models still are very desirable for making rough predictions and for generating hypotheses about the mechanisms of protein folding. Still, Dr. Brooks stressed that current models need what he termed "a better way" of taking into account the many three-dimensional interactions occurring among the thousands of atoms within a protein.

Among the other scientific presentations, Dr. Cozzarelli described how interdisciplinary work conducted in the Program in Mathematics and Molecular Biology has unraveled some of the secrets of DNA. For example, one of his graduate students, Ken Kreuzer, has made a key finding about how an antibiotic called nalidixic acid works. The drug ordinarily kills not only bacteria, but also certain kinds of bacteriophages, or viruses that normally infect bacteria. Biologists had thought the antibiotic worked by disabling an enzyme called DNA gyrase, which they believed was essential for both the bacteria and the bacteriophages to grow. Enzymes serve as biochemical catalysts that speed up normal chemical reactions in cells. Without the DNA gyrase, then, both the bacteria and the bacteriophages would be expected to die.

In his work, Mr. Kreuzer discovered a mutant strain of bacteria in which the production of DNA gyrase could be turned off by raising the temperature. When he subjected the bacteriophages to a "double whammy" of both increased temperature and nalidixic acid, they should have been in even more trouble. Yet, paradoxically, they grew normally. "That must mean that nalidixic acid does not *deprive* the cell of gyrase, but it *corrupts* the DNA gyrase in the cell, and poisons it from within," Dr. Cozzarelli said. The bacteriophages were killed by the poisoned gyrase, but grew well if there was no gyrase at all. But this raised the question of why the bacteria needed DNA gyrase, if the bacteriophages didn't. The answer also came through interdisciplinary collaboration. The story began when Dr. Cozzarelli developed a new technique for coating DNA, enabling him to see the structure of DNA "knots" using an electron microscope. "We had a field day," said Dr. Cozzarelli. "All of a sudden we could do something no one else in the world could do."

But though they could see the knots, his group couldn't tell what they meant. A single enzyme would twist, cut, or paste the cell's DNA in only one particular way, but no microscope could follow its action directly. The only clue was the knotted DNA it left behind. For example, one enzyme would always turn a loop of DNA into a simple link after one step, a figure-eight knot after two steps, and a certain more complicated link (called a "Whitehead link") after three steps. What combination of twisting, cutting, and pasting would cause that? The question was a perfect one for "knot theorists" like program codirector Dr. Sumners to tackle. The answer, it turned out, involves a phenomenon called "supercoiling." Through supercoiling, the cells package DNA so that it can be separated later by another enzyme—in the same way that looping a tangled garden hose makes it easier to put away. Thus, when the action of DNA gyrase in bacteria is stopped, the cells can no longer neatly coil their DNA and hence cannot divide. The bacteriophage DNA, on the other hand, is short enough that it can untangle itself unaided. "The whole story," Dr. Cozzarelli said, "has a nice completeness and brings together theory, biochemistry, and genetics."

> *"I can, in theory, build a tiny DNA 'house' that self-assembles in water, all by programming the DNA bricks."*
> *—Dr. Erik Winfree*

Erik Winfree, Ph.D., a postdoctoral researcher in the Caltech Initiative in Computational Molecular Biology, addressed the problem of controlling the detailed structure of matter on the finest possible scale, a major goal of chemistry, materials science, and nanotechnology. Achieving such control would greatly aid the fabrication of objects specified with nanometer precision, such as molecular electronic components, molecular sieves, and biochips. Accomplishing this goal requires two steps: first, the construction of individual molecules, or "bricks," using synthetic chemistry; and second, the arrangement of the bricks into larger patterns and structures. Capitalizing on the unique capacity of DNA to form complex branched molecules, as well as on the capacity for differently programmed DNA bricks to fit together only in certain ways, like jigsaw puzzle pieces, Dr. Winfree designed a collection of eight DNA bricks. Under the right temperature conditions, these bricks spontaneously assembled into a beautiful pattern known to mathematicians as "Sierpinski's triangle," something like a carpet with triangular motifs that repeat nonperiodically, in larger and larger scales. This work demonstrated powerfully the potential of using pieces of DNA to create self-assembling nanostructures. Among the possible future applications that can be imagined for DNA's self-assembling properties is the design of so-called "DNA computers," which essentially would use DNA in place of a conventional computer's electronic circuitry. But Dr. Winfree said he believes the nearest-term application may be in the design of various types of microscopic structures that would be useful in both science and industry. "I can, in theory, build a tiny DNA 'house' that self-assembles in water—all by programming the DNA bricks," he told the workshop. "I stress—'in theory.'"

Students at the Interface

The poster presentations by the programs' graduate and postdoctoral students also provided a bounty of food for interdisciplinary thought. For example, a poster presented by Andrew Ewald of the Caltech program explained an application of physics to the study of neural crest cells in vertebrate embryos. Mr. Ewald works with Scott Fraser, Ph.D., the program's codirector. Neural crest cells originate along a structure in the developing nervous system called the neural tube and then migrate to a variety of destinations around the body, where they differentiate into various cell types, such as neurons in the peripheral nervous system, bones and muscles in the head, and pigment cells in the skin. But no one knows how the neural crest cells "decide" on their final destination. The simplest possible explanation, that each cell has a genetic program telling it where to go, is not borne out by experiment: if one of the neural crest cells is removed, the others compensate. The animal develops normally, not with a missing leg or head.

One student called interdisciplinary work "yoga for the mind." Many also commented on the excitement of doing research that might lead to tangible benefits for society.

To study how the cells move and, in particular, how various proteins tell them where to go, Dr. Fraser's laboratory uses "stripe assays," in which the proteins are painted onto a plastic substrate. But the existing method, according to Mr. Ewald, had two problems. Plastic is not very transparent, so the cells (and their insides) could not be seen as clearly as the experimenters wanted. Also, surface tension was distorting their readings, causing the cells to migrate to the edges of the protein strips. But as a physics undergraduate, Mr. Ewald had learned how to bind proteins chemically to gold. By adapting the procedure to glass, he could make more uniform strips on a more transparent medium. "Physicists are really good at patterning light," he said. "A lot of [solving the problem] was just awareness of what can be done."

Mr. Ewald, who had been turned off by his undergraduate biology courses because they involved so much memorization, liked Caltech's interdisciplinary program because the biologists welcomed people with different backgrounds. "The biologists said, 'We need you,'" Mr. Ewald recalled. "One thing that [the BWF workshop] didn't bring out was that there are many new fields where biologists are ready to ask other scientists for help. There's a bigger payoff to that than being the thousandth person to work on protein folding."

On the whole, students in the various interdisciplinary programs seemed to have a positive view of the workshop experience, not only because of the information presented about career opportunities but also for its intellectual richness. Their enthusiasm about the workshop may have stemmed, in part, from the general excitement they bring to "doing science at the interface." One student called interdisciplinary work "yoga for the mind." Many also commented on the excitement of doing research that might lead to tangible benefits for society. For example, Heather Carlson, a postdoctoral fellow at the University of California-San Diego who works in the La Jolla Interfaces in Science Training Program, studied quantum mechanics as an undergraduate but "wanted to do something more relevant than study four carbons or four hydrogen atoms." At the workshop, she presented a poster about her research on the structure of HIV-1 integrase protein, which could be useful in designing new anti-AIDS drugs.

Lessons for the Future

In her remarks at the workshop's closing banquet, BWF President Dr. Enriqueta C. Bond summarized some of the messages she had gotten repeatedly from the various participants. "We heard there's a desire for a website or a clearinghouse" for information on interdisciplinary studies and funding opportunities, she noted. One participant suggested the Project NExT discussion list in mathematics, conducted by the Mathematical Association of America, as a good model to follow. "We definitely heard that additional meetings and workshops are valuable to you," she continued, going on to challenge participants to come up with proposals for such workshops and send them to the Burroughs Wellcome Fund. "We heard that money is power," Dr. Bond said. This line, from one of the focus groups, had gotten a big laugh; but it generally was agreed that money helps give a new project credibility, and money granted directly to postdocs could give them the independence they need to stake out their own research direction.

Interdisciplinary research poses great challenges, but the payoffs—for individual scientists as well as for society at large—are equally great.

The overall lesson, then, seemed to be that successful interdisciplinary research involves the active cooperation of scientists with diverse but relevant backgrounds, who contribute their individual talents and expertise to addressing complex problems of mutual interest. Collaborative research flourishes in academic environments that have a free flow of communication and active interdepartmental programs that are recognized and encouraged by faculty peers and institutional administrators. In addition, successful collaboration requires some extra effort from individual researchers, who often must adapt to unfamiliar scientific cultures and overcome impediments imposed by specialized scientific language and jargon, as well as by differences in academic traditions, budgetary priorities, sources of funding, and approaches to research among the relevant disciplines. So, the challenges involved in fostering interdisciplinary research are great, but the payoffs—for individual scientists as well as for society at large—are equally great. In the spirit of the workshop participants, boundaries are where the real excitement is.

This article is adapted from a workshop summary prepared by Dana Mackenzie, Ph.D., a science writer based in Santa Cruz, California.

Website addresses for BWF interfaces programs:

1996 Programs
California Institute of Technology: http://www.cco.caltech.edu/~cmb
La Jolla Interfaces in Science Training Program: http://ljis.ucsd.edu
Program in Mathematics and Molecular Biology: http://zeno.math.fsu.edu/~pmmb
Rockefeller University: website under construction

1998 Programs
Brown University: http://neuroscience.brown.edu/Neuropage/bbs.html
Johns Hopkins University: website under construction

Making Science and Mathematics Real for Kids

Children are natural scientists. They observe, ask questions, gather information, solve problems: "How does the microwave work?" "Why do people yawn?" "What makes a hurricane?" "Do animals have emotions?"

Somewhere after the elementary school years, however, children tend to lose their zeal. Science and mathematics become "too hard," "too abstract," or even worse, "booooring." For today's students, the memorization of facts and formulas is not enough: they want to *do* things, to *experience* what they are learning, and most of all, to *see* its relevance in their lives. Science can—and should—be the vehicle that opens the door to relevancy and engagement. But how can we reach kids? Capture their interest? Encourage them to seek careers in science and mathematics?

The Burroughs Wellcome Fund is working to answer questions like these. As described in earlier sections, BWF's primary grantmaking strategies are to support the development of scientists early in their careers and to support undervalued areas of science. Attracting young people to science and mathematics fits into accomplishing both of these goals. With this in mind, BWF's Board of Directors convened a Science Education Advisory Task Force made up of leaders in education, science, and technology. The group reinforced what the board itself strongly believed—*that the best way to get students involved in science is through hands-on, engaging activity*—and agreed to help guide BWF's science education program.

The result is BWF's Student Science Enrichment Program (SSEP), which awards approximately $1 million per year for creative science, mathematics, and technology programs conducted outside the usual school environment. Currently focused on BWF's home state of North Carolina, SSEP targets middle school and high school students who show exceptional talent and interest in science and mathematics or who are perceived to have high potential. The first class of 12 SSEP programs was funded in 1996, with an additional eight programs in 1997 and eight more in 1998. The programs receive from $60,000 to $180,000 over three years. (Current SSEP programs are listed in the "Grants Index" section, beginning on page 71.)

The SSEP program is intended to expand students' competence and knowledge in science, nurture their enthusiasm for science, and interest them in pursuing careers in science and related areas. There is one key requirement: the experiences must be exciting, mind-expanding, and hands-on. Beyond that, BWF suggests that the programs provide an environment to "do" science using inquiry-based exploration, connect science to students' daily lives, offer insight into and appreciation of the investigative process, enable students to interact with scientists, give students an opportunity to explain their knowledge of science to others, supply students with science-related career information, and provide follow-up opportunities to link students to ongoing science programs.

The need to improve middle school and high school science education—in North Carolina and nationwide—is great, as witnessed by the lackluster performance of U.S. students in one international test after another. For example, a 1998 report from the Third International Mathematics and Science Study showed that U.S. high school seniors perform *below* the international average and among the lowest of the 21 countries included in the study. Even our best students lag behind their peers in other developed nations. This news is particularly significant in the wake of previous studies by the same organization that showed U.S. fourth graders ranking *above* average on these tests and eighth graders ranking just slightly below.

Many reasons have been cited for such a disappointing performance. Science has been a foreign subject for most U.S. students. Most young people don't come into contact with scientists or mathematicians and don't know what they do. Few are aware of the wide range of related career opportunities—and this gap is even greater for girls and minorities. Most schools focus on covering large amounts of information, while those in higher-achieving countries focus on how to apply knowledge to real-world problems. School schedules do not give students enough time to learn how to apply mathematics and science concepts to challenging problems. Students are in school for fewer days (about half the days of the year, compared with two-thirds in Asian schools) and for fewer hours (30 hours per week, compared with 44 hours in Asian schools). Science is therefore generally taught in the classroom, from a textbook. But as the American Association for the Advancement of Science (AAAS) concluded in its 1990 report *Science for All Americans*: "In science, conclusions and the methods that lead to them are tightly coupled…Science teaching that attempts solely to impart to students the accumulated knowledge of a field leads to very little understanding and certainly not to the development of intellectual independence and facility." The Howard Hughes Medical Institute, the largest private funder of science education, came to the same conclusion. According to a 1996 institute report: "Anecdotal and empirical evidence support the value of hands-on, inquiry-based learning and strong family and community support in developing and sustaining interest in science…Laboratory research experience, access to faculty mentors and compelling courses taught in well-equipped, state of the art facilities have all been cited as pivotal factors in students' decisions to persist in the sciences."

Most young people don't come into contact with scientists or mathematicians and don't know what they do.

Learning by Doing…and by Having Fun

The message, then, is that hands-on science is a key to success. Think about it. Think about building a bridge from spaghetti and Elmer's glue. Conducting cardiovascular research alongside leading scientists. Analyzing fingerprints and hair to solve a forensic "crime." Studying animals living in an estuary. Performing and presenting in-depth experiments on chaos and fractals.

Sound like fun? It is, for the students participating in BWF's Student Science Enrichment Program. It's so much fun, in fact, that students often don't realize how much they're learning. And that, of course, is the point. While disadvantaged students are shopping for supplies and cooking a meal, they are learning how chemistry works and why fractions are useful in everyday life. Girls participating in a mentoring program are being exposed to various careers in science, with female scientists as role models. Students doing directed research in science and mathematics on the Internet are experiencing firsthand the fundamental skills of observation, measurement, and analysis. Students building a nature trail are gaining awareness of the richness of the environment and sharing that information with others.

But fun, of course, isn't a complete measure. From the beginning, BWF has been committed to evaluating the SSEP's effectiveness and making improvements as necessary. The first step was bringing Horizon Research Inc. on board to help evaluate the program and develop mechanisms for additional evaluation. Horizon's professional evaluators served as outside observers, surveying programs and participants, interviewing directors, visiting particular programs for a closer view, and analyzing data from students. Just as important, in January 1998 BWF brought together representatives of the first 20 SSEP programs to discuss experiences, successes, and concerns. That internal perspective supported the initial evaluation results and went a step further in considering common challenges and ways to improve, as summarized below.

Diversity. If the SSEP profiles show anything, it is that there is no "average" program. As one observer commented, "There are as many definitions of 'hands-on' as there are letters in the alphabet." The evaluation showed that the programs include both newly created and existing initiatives; focus on everything from computers to environmental science; contact participants anywhere from 8 to 240 hours per year; and are sponsored by a wide range of organizations, including colleges and universities, community groups, museums, public and private schools, and scientific organizations.

While disadvantaged students are shopping for supplies and cooking a meal, they are learning how chemistry works and why fractions are useful in everyday life.

Perhaps the most outstanding characteristic of the SSEP programs is their capacity to reach a wide range of students. Programs serve everyone, from those identified as gifted and talented, to those whose interest in science has been dulled by less than ideal school conditions, and to those who have potential but have never thought of themselves as scientists. Considering this diversity, the best way to describe the SSEP may be to provide a sampling of individual programs:

- The Science and Mathematics Colloquies at North Carolina State University's Science House enable academically gifted high school students from across the state to learn how science is done, by working with scientists and performing in-depth experiments on topics ranging from sports science to global climate change.

- The Science and Technology around Research Triangle Park (START-UP) program of the Pines of Carolina Girl Scout Council gives cadet and senior scouts a chance to participate in hands-on science activities, learn from female science mentors, and share their new knowledge with younger girls in a safe, supportive environment.

- The Circle of Support program at Catawba Science Center lets minority students from 12 middle schools and high schools participate in a three-tiered program: as members of a weekly science club, as junior volunteers giving floor demonstrations, and ultimately as paid "junior naturalists."

- The Stimulating Understanding of Computational Science through Collaboration, Exploration, Experiment, and Discovery (SUCCEED) program, conducted by the Shodor Foundation, enables middle school and high school students to interact with their peers as well as with scientists to use cutting-edge technology and investigate complex scientific and mathematical phenomena.

- The Science and Technology Skill Building for Female Students and Their Female Teachers program, conducted by Appalachian State University, brings together female science teachers and middle school girls from the northwestern part of the state to build their science and technology skills and expand their perspectives about science.

- The Cape Fear High School Science Academy, conducted by the Cumberland County Schools, enables high school students to spend a month during the summer working alongside scientists studying various environmental aspects of Carolina Bay.

Enthusiasm. More than 1,000 students participated in the programs during the SSEP's first year. The group included a high proportion of girls (62 percent), minorities (48 percent), and students who describe themselves as "strong all around" (40 percent) —in other words, the groups the program was intended to serve.

Those who participated were enthusiastic about the experience: over three-fourths said the material was interesting and stimulated them to think about things they hadn't thought about before. In their own words: "It was really cool what we found out." "I enjoyed meeting other young people like me. I felt normal and included." "I learned something new every day." "The program let me explore parts of science that I didn't know about." "I found today most intriguing and can't wait for next Wednesday!"

Some programs, however, found it difficult to recruit the number of students anticipated from the targeted populations, and a few programs had difficulty retaining participants. Indeed, at BWF's January meeting, recruitment was a major topic of discussion among directors, who agreed that it was essential to get "buy-in" from parents and teachers. Other ideas for recruitment included extending one-to-one relationships and promotional materials to churches, the media, school social events, businesses, and BWF's own board members.

"I found today most intriguing and can't wait for next Wednesday!"
—SSEP student

Engagement. The popularity of the enrichment programs is closely related to the emphasis on engaging activities. Two-thirds of the students reported that they had conducted hands-on explorations every time the program met, and these programs tended to receive the most positive responses. Participants further reinforced the value of the SSEP's approach in their suggestions for improvement: the consensus was "more hands-on!" Favorite activities cited include building electronic devices, including a telephone; handling earthworms, snakes, and other animals; learning about electrocardiograms and going to a medical center to have one done; working with computers; and observing the life cycle of fruit flies.

The real challenge, directors and evaluators concluded, is to find the proper balance between having fun and providing content. The programs that tend toward the "fun" side of the equation are likely to be popular, but may not achieve their overall goals. Those that lean too far in the other direction may lose students' interest. Additionally, the programs must keep in mind the particular needs of students, based on such factors as age and exposure to science. For example, since most high school students work in the summer, a stipend often is necessary to attract participants.

Partnership. The SSEP has brought together museums, schools, community groups, businesses, and colleges and universities in partnerships that make new resources available to students. To list but a few examples: The North Carolina Museum of Life and Science is partnering with local public schools to provide hands-on after-school experiences. The University of North Carolina-Wilmington collaborates with the National Undersea Research Center and the North Carolina School of Science and Mathematics to conduct oceanographic research. The American Heart Association's North Carolina Council is collaborating with the state's medical schools to create laboratory-based research opportunities for high school students.

Indeed, the SSEP program directors expressed great interest in collaboration. While most have established good relationships in the community, they want to do even more to reach out, especially to those populations that traditionally have been underserved. The directors emphasized the need to identify resources from the start and to consider a wide variety of alliances—with businesses, American Medical Association members, students, museums, Parent Teacher Associations, the media, and foundations.

Results. It is too early to tell what the SSEP's longer-term impact will be. However, pre-testing and post-testing of participants indicated that their attitudes toward science had changed. At the conclusion, more students agreed with the statement "I am good at science," while fewer agreed that "Science usually makes me feel uncomfortable or nervous." Even more significant was the number of students who "Expect to use science in my work as an adult"—which jumped from 36 percent to 62 percent.

Students who are engaged actively in science are more likely to stick with it, take advanced high school classes, continue in college and university courses, and pursue related careers.

The SSEP experience also suggests that students who are engaged actively in science are more likely to stick with it, take advanced high school classes, continue in college and university courses, and pursue related careers. Some examples: All members of the first graduating class of the Durham Public Schools Summer Institute, conducted by Durham Academy, went on to college, and 100 percent went into the sciences. Students graduating from the University of North Carolina Mathematics and Science Education Network's Pre-College Exploring Science Program are more likely to take algebra in high school, and their scores are significantly above the statewide average in both algebra and physical science. Most graduates of the American Heart Association's High School Student Research Program enter college with an interest in scientific fields, ranging from basic biology to medical science.

Reaching More Kids

From national assessments to BWF's experience, all the evidence suggests that hands-on education works. But even with the growth of opportunities the Student Science Enrichment Program represents, such programs are still reaching a small proportion of the state's students. How can programs like these be extended to more young people? How can they be made an integral part of the way all students experience science and mathematics?

Some lessons have emerged from BWF's continuing assessment—lessons that may prove valuable not only in North Carolina but across the nation. At the program level, the primary issue facing the SSEP is continuity. Program directors need to link to one another and share information about challenges, strategies, and lessons learned. Individually and together, the programs should focus on making enrichment activities integrate seamlessly with the students' formal education. Most important of all, the programs must find ways to assure their own sustainability beyond the initial funding cycle. At the state level, the issue is migration into the schools. To reach more students, the lessons learned through SSEP must be integrated into the middle school and high school science curricula. The state can serve as a springboard to bring the excitement of these programs into the schools.

For BWF's part, the critical issues are evaluation and communication. The Fund needs to develop the mechanisms to evaluate what works—and what doesn't—in hands-on science education. With this information, BWF can serve a powerful role in disseminating innovative models represented by particular programs. BWF also can provide information on what national organizations are doing to improve science, mathematics, and technology education. Finally, by enhancing the visibility of the programs it is supporting, BWF can help in promoting student recruitment and attracting additional resources.

Looking beyond the immediate lessons from the SSEP program, other improvements also will be needed. An important step is to set standards for what students must know and be able to do at various stages in their education. The National Academy of Sciences already has begun this process, publishing standards in biology and mathematics and moving into other such areas as chemistry and physics.

How science is taught is equally important. As the American Association for the Advancement of Science concluded in its *Science for All Americans* report: "Young people can learn most readily about things that are tangible and directly accessible to their senses—visual, auditory, tactile, and kinesthetic. With experience, they grow in their ability to understand abstract concepts, manipulate symbols, reason logically, and generalize. These skills develop slowly, however, and the dependence of most people on concrete examples of new ideas persists throughout life."

The teaching of science also must be consistent with the practice of science. According to the AAAS, that means eight things: start with questions about nature, engage students actively, concentrate on the collection and use of evidence, provide historical perspectives, insist on clear expression, use a team approach, do not separate knowing from finding out, and de-emphasize the memorization of technical vocabulary. The SSEP program is based on these principles. By creatively engaging students in "real-world" activities, the enrichment programs give them an opportunity to experience science, mathematics, and technology firsthand. As one experienced teacher told BWF: "We're raising kinesthetic and tactile kids, kids who are interested in doing things, kids who ask, 'Why do I need to know this?' They have to feel and touch, to see the relevance of their education, to feel that they're making a difference."

"We're raising kinesthetic and tactile kids, kids who are interested in doing things, kids who ask, 'Why do I need to know this?'"
—SSEP teacher

A Collaborative Effort

The Burroughs Wellcome Fund is proud of its role in this arena. The enrichment activities funded through the SSEP already have reached approximately 14,000 students. In addition, BWF is involved in complementary efforts at the state level to improve the climate for science and mathematics education in North Carolina.

In one landmark effort, BWF provided $1 million to establish the Education Future Center, which electronically connects educators, students, and the local communities around the state to resources that will significantly improve how science and mathematics are taught and learned. The center includes a network of technology-rich classroom sites, called "cyber campuses," at seven locations. Each cyber campus—strategically located in rural, remote, or underserved areas, and collectively serving 51 of the state's 100 counties—will be linked via the North Carolina fiber-optic network, which provides high-quality data, audio, and video transmissions. The North Carolina School of Science and Mathematics serves as the center's main hub, sharing resources and training opportunities. Within two years of receiving BWF's grant, the Education Future Center has raised approximately $17 million, including $6.4 million from the U.S. Department of Education to improve teacher training via the cyber campuses.

In another major effort, BWF supports the new Institute for Educational Policymakers, led by the Public School Forum of North Carolina. The institute—the first of its kind and considered a model for the nation—brings together members of the North Carolina legislature and the Board of Education for shared learning at project seminars, circulates research and articles, and hosts site visits to exemplary schools and universities. The institute also provides reporters in various media with timely and factual information on current and emerging issues in education. Judging from initial responses, this approach offers great potential to help bipartisan elected and appointed officials deal with the complex issues related to school improvement, especially in the areas of science, mathematics, and technology, and to help inform public discourse on these vital matters.

Of course, moving forward with improvements in science education will require more than the efforts of a single private foundation. It will depend on a collaborative effort among many organizations operating at various levels. It is up to all of us—individually and collectively—to awaken young people's interest in science, mathematics, and technology; to ignite their enthusiasm for new ways of looking at the world; and to refresh their natural inclination to observe, wonder, and question. After all, their future—and ours—depends on it.

Moving forward with improvements in science education will require more than the efforts of a single private foundation.

This article is adapted from a program summary report prepared by Debbie Lee Averitt, an education consultant and writer based in Raleigh, North Carolina.

Finance

Scott G. Schoedler
Vice President,
Finance

The Burroughs Wellcome Fund's investments totaled $552.2 million at August 31, 1998, the end of BWF's fiscal year. BWF's primary financial goal is to pursue an investment strategy that will support annual spending needs and maintain a constant real level of assets over the long term. To achieve this goal, substantially all of BWF's investments are placed in asset classes that provide exposure to U.S. and international capital markets. Hence, fluctuations in BWF's investment results will be due largely to variability in capital market returns.

BWF's investment policies are developed with the recommendations and review of the Investment Committee, which is appointed by and reports to BWF's Board of Directors. The committee's five voting members include two representatives of our board and three representatives from outside the Fund. The board's chair, BWF's president, and BWF's vice president for finance also serve on the committee as nonvoting members. As of August 31, Stephen D. Corman, BWF's treasurer, and Mary Ellen Avery, M.D., represented the board as voting members, with Mr. Corman serving as committee chair. The committee's external members were J. Thomas Allen, president of Advanced Investment Management; W. Curtis Livingston, chair and chief executive officer of Western Asset Management; and Ronald Frashure, executive vice president of Acadian Asset Management. The Investment Committee has three regularly scheduled meetings each year. Two of the meetings coincide with BWF's board meetings in February and October, while the third meeting is held in June.

As part of our investment strategy, BWF has established "allocation targets"—that is, percentages of the Fund's total assets to be invested in particular asset classes. Investment managers hired by the Fund pursue more focused mandates within each sector. At August 31, 1998, BWF's asset mix and market values were:

- U.S. large capitalization equity assets had a market value of $192.6 million. The sector's target allocation was 40 percent, and actual holdings stood at 34.8 percent.

- U.S. small capitalization equity assets had a market value of $71.1 million. The sector's target allocation was 13 percent, and actual holdings stood at 12.9 percent.

- International equity assets had a market value of $125.4 million. The sector's target allocation was 23 percent, and actual holdings stood at 22.7 percent.

- U.S. fixed income assets (bonds) had a market value of $142.8 million. The sector's target allocation was 21 percent, and actual holdings stood at 25.9 percent.

- Alternative assets had a market value of $1.5 million. The sector did not have a target allocation, as this represents a new area of investment for BWF; actual holdings stood at 0.3 percent.

- Cash equivalent assets had a market value of $18.8 million. The sector's target allocation was 3 percent, and actual holdings stood at 3.4 percent.

The total market value of BWF's investments decreased by $43.6 million, or 7 percent, from the August 31, 1997, market value of $595.8 million. BWF posted a -2.2 percent return on investments for fiscal 1998, which followed a 26.5 percent return on investments for fiscal 1997. The primary reason for this significant reduction in investment return was the sub par returns in world capital markets during the fiscal year, particularly in July and August of 1998. Market volatility was very high throughout the period, with some sectors, such as U.S. small capitalization stocks and emerging markets securities, faring very poorly. In terms of overall investment performance, BWF's bond managers had the best fiscal year result, posting an 11.4 percent return—a sharp reversal from 1995, 1996, and 1997, when U.S. equity managers led the way. For fiscal 1998, managers of U.S. large capitalization stocks followed bond managers, with a 2.8 percent return. Managers of international stocks posted a -13.0 percent return, and managers of U.S. small capitalization stocks posted a -17.6 percent return for the period. In relative terms, the investment results were mixed. The bond and small capitalization managers surpassed their respective industry-accepted performance benchmarks, while the large capitalization managers and international equity managers underperformed.

BWF's primary financial goal is to pursue an investment strategy that will support annual spending needs and maintain a constant real level of assets over the long term.

As of August 31, 1998, BWF employed 10 investment managers. In the U.S. large capitalization equity sector, the managers were Independence Investment Associates; Brandywine Asset Management; and Cohen, Klingenstein and Marks. Kennedy Capital Management and Scudder, Stevens and Clark managed U.S. small capitalization equities. Pacific Investment Management Company and Smith Breeden Associates were the U.S. bond managers. Capital Guardian Trust Company, Indago Capital Management, and Hansberger Global Investors managed international equities.

BWF reviews our strategic investment policy every three years, and the Investment Committee conducted its most recent review in late 1996. As one result of this review, the committee decided to allocate up to 5 percent of BWF's total assets to alternative investments, defined as investments that do not fall into the traditional stock, bond, and cash asset classes. In fiscal 1998, BWF committed to and funded our first alternative investments—the venture capital partnerships Intersouth Partners IV and Spray Venture Fund. Also, in early fiscal 1999 BWF made a commitment to a third venture capital fund—the North Carolina Bioscience Fund. All three funds specialize in medical and/or biotechnology investments and thus provide excellent counterparts to BWF's program activities. Continued investment in the alternatives sector is expected in fiscal 1999, as the three commitments comprise approximately 1.5 percent of BWF's assets, well below the 5 percent target allocation level.

Financial Statements and Additional Information

Report of Independent Accountants

To the Board of Directors of
The Burroughs Wellcome Fund

In our opinion, the accompanying statement of financial position and the related statements of activities and of cash flows present fairly, in all material respects, the financial position of The Burroughs Wellcome Fund (the "Fund") at August 31, 1998 and 1997, and the changes in its net assets and its cash flows for the years then ended in conformity with generally accepted accounting principles. These financial statements are the responsibility of the Fund's management; our responsibility is to express an opinion on these financial statements based on our audits. We conducted our audits of these statements in accordance with generally accepted auditing standards which require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements, assessing the accounting principles used and significant estimates made by management, and evaluating the overall financial statement presentation. We believe that our audits provide a reasonable basis for the opinion expressed above.

Our 1998 audit was conducted for the purpose of forming an opinion on the basic financial statements taken as a whole. The information presented in Schedules I and II is presented for purposes of additional analysis and is not a required part of the basic financial statements. Such information has been subjected to the auditing procedures applied in the audit of the basic financial statements and, in our opinion, is fairly stated in all material respects in relation to the basic financial statements taken as a whole.

PricewaterhouseCoopers LLP

PricewaterhouseCoopers LLP
Raleigh, North Carolina
October 9, 1998

STATEMENTS OF FINANCIAL POSITION

August 31, 1998 and 1997
(All dollar amounts presented in thousands)

	1998	1997
ASSETS		
Cash and cash equivalents	$ 26,541	$ 39,196
Marketable securities	531,751	571,452
Accrued interest and dividends receivable	1,666	1,135
Other assets	55	15
Construction-in-progress	2,435	473
Property and equipment, net (accumulated depreciation of $83 and $34 in 1998 and 1997, respectively)	-	49
Total assets	$ 562,448	$ 612,320
LIABILITIES AND NET ASSETS		
Transactions payable, net	$ 7,103	$ 15,661
Accounts payable and other liabilities	1,257	1,200
Unpaid awards	52,193	40,043
Federal excise taxes payable	-	99
Deferred federal excise tax liability	-	1,526
Total liabilities	60,553	58,529
Commitments and contingencies (Note 6)		
Unrestricted net assets	501,895	553,791
Total liabilities and net assets	$ 562,448	$ 612,320

The accompanying notes are an integral part of these financial statements

STATEMENTS OF ACTIVITIES

Years Ended August 31, 1998 and 1997
(All dollar amounts presented in thousands)

	1998	1997		
	Unrestricted	Unrestricted	Temporarily Restricted	Total
Revenues:				
Contributions	$ -	$ -	$ 3,157	$ 3,157
Interest and dividends, less investment expenses of $3,184 and $2,832 in 1998 and 1997, respectively	14,101	12,884	-	12,884
Net realized gain on sales of marketable securities	61,197	48,024	-	48,024
Net assets released from restrictions	-	81,692	(81,692)	-
Total revenues	75,298	142,600	(78,535)	64,065
Expenses:				
Program services	34,845	33,409		33,409
Management and general	5,479	4,401	-	4,401
Total expenses	40,324	37,810	-	37,810
(Decrease) increase in unrealized (depreciation) appreciation of marketable securities, net of (benefit of) provision for deferred federal excise taxes of ($1,526) and $1,133 in 1998 and 1997, respectively	(86,870)	55,512	-	55,512
Change in net assets	(51,896)	160,302	(78,535)	81,767
Net assets at beginning of year	553,791	393,489	78,535	472,024
Net assets at end of year	$ 501,895	$ 553,791	$ -	$ 553,791

The accompanying notes are an integral part of these financial statements

STATEMENTS OF CASH FLOWS

Years Ended August 31, 1998 and 1997
(All dollar amounts presented in thousands)

	1998	1997
Cash flows from operating activities:		
Change in net assets	$ (51,896)	$ 81,767
Adjustments to reconcile change in net assets to net cash provided by operating activities:		
Depreciation	49	9
Net realized gain on sales of marketable securities	(61,197)	(48,024)
Decrease (increase) in unrealized depreciation (appreciation) of marketable securities	88,396	(56,645)
(Benefit of) provision for deferred federal excise taxes	(1,526)	1,133
Awards granted, net of cancellations and change in unamortized discount	34,931	33,453
Award payments made	(22,781)	(21,304)
Decrease in contributions receivable	-	78,535
Change in transactions receivable/payable, net	(8,558)	67,997
Increase in accrued interest and dividends receivable	(531)	(221)
(Decrease) increase in other assets	(40)	3
Increase in accounts payable and other liabilities	57	638
(Decrease) increase in federal excise taxes, net	(99)	99
Net cash (used in) provided by operating activities	(23,195)	137,440
Cash flows from investing activities:		
Purchases of marketable securities	(1,160,261)	(1,558,859)
Proceeds from sales of marketable securities	1,172,763	1,445,025
Increase in construction-in-progress	(1,962)	(422)
Net cash provided by (used in) investing activities	10,540	(114,256)
Net (decrease) increase in cash and cash equivalents	(12,655)	23,184
Cash and cash equivalents at beginning of year	39,196	16,012
Cash and cash equivalents at end of year	$ 26,541	$ 39,196
Supplemental disclosure of cash flow information:		
Cash paid during the year for federal excise taxes	$ 2,009	$ 1,001

The accompanying notes are an integral part of these financial statements

NOTES TO FINANCIAL STATEMENTS

Years Ended August 31, 1998 and 1997
(All dollar amounts presented in thousands)

1. Organization and Summary of Significant Accounting Policies

The Burroughs Wellcome Fund (the "Fund") is a private foundation established to advance the medical sciences by supporting research and other scientific and educational activities.

Cash equivalents
Cash equivalents are short-term, highly liquid investments that are readily convertible to known amounts of cash and have a maturity of three months or less at the time of purchase.

Forward currency contracts
The Fund enters into financial instruments with off-balance sheet risk in the normal course of its investment activity, primarily forward contracts, to reduce the Fund's exposure to fluctuations in foreign currency exchange rates. These contracts are for delivery or sale of a specified amount of foreign currency at a fixed future date and a fixed exchange rate. Gains or losses on these contracts occur due to fluctuations in exchange rates between the commencement date and the settlement date. Gains and losses on settled contracts are included within "net realized gains on sales of marketable securities," and the market value of open contracts is included within "increase (decrease) in unrealized appreciation of marketable securities" in the accompanying statement of activities. It is the Fund's policy to utilize forward contracts to reduce foreign exchange rate risk when foreign-based investment purchases or sales are anticipated.

The contract amount of these forward contracts totaled $3,740 and $7,620 at August 31, 1998 and 1997, respectively. Realized gains on forward currency contracts totaled $474 and $659 in 1998 and 1997, respectively. The market value of open contracts at August 31, 1998 and 1997 was $133 and $281, respectively. The market value is recorded as an asset in the Fund's financial statements. The average fair value of open contracts totaled $281 and $164 for the years ending August 31, 1998 and 1997, respectively.

Futures contracts
The Fund enters into futures contracts in the normal course of its investment activity to reduce the exposure to interest rate risk associated with bonds and mortgage backed securities. The Fund is required to pledge collateral to enter into these contracts. The amounts pledged for long futures contracts at August 31, 1998 and 1997 were $69,300 and $10,500, respectively, which are offset by amounts pledged for short futures contracts totaling $60,900 and $1,000 at August 31, 1998 and 1997, respectively. It is the Fund's intention to terminate these contracts prior to final settlement. Gains and losses on the contracts are settled on a daily basis. Included in transactions payable at August 31, 1998 and 1997 is the net settlement relating to these contracts of $80 and ($51), respectively.

Marketable securities
Marketable securities are carried at estimated market values based on quoted prices. Gains and losses from sales of securities are determined on an average cost basis and are recognized when realized. Changes in the estimated market value of securities are reflected as unrealized appreciation or depreciation in the accompanying statement of activities. The Fund has ten investment advisors which manage its portfolio of marketable securities. The Fund's management critically evaluates investment advisor performance and compliance with established diversification and investment policies.

Transactions receivable and transactions payable, net
These amounts represent the net receivable or payable resulting from investment transactions with trade dates prior to August 31 and settlement dates subsequent to August 31.

Contributions
Contributions are recorded as assets and revenue at the time pledged at their estimated realizable value and are discounted to present value using a risk-free discount rate determined at the time the contribution is recorded. Conditional contributions are recognized when the conditions on which they depend are substantially met. Contribution revenue represents changes in the fair value of contributions receivable from The Wellcome Trust and contributions pledged.

Property and equipment
Property and equipment are depreciated over estimated useful lives ranging from four to fifteen years using the straight-line method.

Awards granted and unpaid awards
Grants are expensed at their fair value in the year in which the award is granted. Grants payable over several years are expensed, and carried on the statements of financial position, at the present value of their estimated future cash flows, using a risk free discount rate determined at the time the award is granted.

Temporarily restricted net assets
Temporarily restricted net assets represent the fair value of contributions receivable from The Wellcome Trust. These net assets become unrestricted when the respective installment from The Wellcome Trust is due to be received by the Fund or when the restriction associated with the contribution is accomplished.

Functional allocation of expenses
Costs of the Fund's operations and activities have been summarized on a functional basis in the statement of activities.

Estimated fair value of financial instruments
Financial instruments include cash and cash equivalents, marketable securities, accrued interest and dividends receivable, contributions receivable, accounts payable, and unpaid awards. All financial instruments are reported at their estimated fair value. The carrying value of accrued interest and dividends receivable, contributions receivable, accounts payable, and unpaid awards approximates fair value based upon the timing of future expected cash flows. The estimated fair value of marketable securities is determined based upon the latest quoted sales price for such securities as of the balance sheet date. The Fund's remaining assets and liabilities are not considered financial instruments.

Reclassifications
Certain amounts in the 1997 financial statements have been reclassified to conform to the 1998 basis of presentation.

Use of estimates
The preparation of financial statements in conformity with generally accepted accounting principles requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. Actual results could differ from those estimates.

2. Construction-in-progress

Amounts paid by the Fund in association with construction of a new facility have been capitalized. The total anticipated cost of the new facility is approximately $10,700.

In October 1997, the Fund entered into a lease agreement for land on which the Fund's new facility is being constructed. The land is being leased from a non-profit North Carolina corporation for a nominal amount through October 2096. The present value of the contributed asset was not capitalized as the balance would not significantly impact the Statements of Financial Position.

3. Federal Excise Taxes

The Fund is exempt from federal income taxes under Section 501(c)(3) of the Internal Revenue Code. However, since the Fund meets the definition of a private foundation under the Internal Revenue Code, it is subject to federal excise tax on its annual net investment income. Deferred federal excise taxes represent the tax liability on unrealized appreciation of marketable securities.

4. Unpaid Awards

Unpaid awards as of August 31, 1998 and 1997 are scheduled for payment as follows:

	1998	1997
Payable in less than one year	$ 20,180	$ 15,688
Payable in one to five years	38,161	30,068
	58,341	45,756
Unamortized discount	(6,148)	(5,713)
Total	$ 52,193	$ 40,043

The expected future liability to the Fund has been calculated based on discount rates ranging from 4.96% to 6.70%.

5. Marketable Securities

The cost and estimated market values of marketable securities at August 31, 1998 and 1997 are as follows:

	1998		1997	
	Cost	Estimated Market Value	Cost	Estimated Market Value
U.S. and foreign governmental obligations	$ 108,108	$ 110,354	$ 98,034	$ 99,583
Corporate bonds	39,118	38,857	22,899	23,164
Common and preferred stocks	255,902	256,012	237,827	297,761
Foreign stocks and foreign equity fund	142,136	127,948	136,383	150,944
Forward foreign currency obligations	(2,815)	(2,950)	-	-
Venture capital investments	1,530	1,530	-	-
	$ 543,979	$ 531,751	$ 495,143	$ 571,452

6. Commitments

The Fund leases office space under an operating lease with a remaining term of seven months. Rental expense for this lease in fiscal 1998 and 1997 was $123 and $141, respectively. Net future minimum lease payments for the remaining term total $79.

7. Employee Benefit and Retirement Plans

The Fund provides medical insurance to all employees working at least thirty hours per week. Coverage extends to each employee's spouse and dependent children, if applicable. The expense for this employee benefit was $83 and $61 during fiscal 1998 and 1997, respectively.

The Fund has a defined-contribution retirement plan covering all employees working at least twenty hours per week. Under the terms of the plan, the Fund matches 50% of all employees' contributions up to 6% of the employee's annual compensation. Employees are 100% vested in employee and employer contributions immediately. The Fund also has a defined-contribution retirement plan funded solely through employer contributions. Under the terms of the plan, the Fund contributes 10% of the employee's annual compensation. This plan covers all employees and vesting in contributions is immediate. The expense for these retirement plans was $34 and $115 in fiscal 1998 and $27 and $94 in fiscal 1997, respectively.

8. Classification of Expenses

	1998		1997	
	Program Services	Management and General	Program Services	Management and General
Awards granted, net of cancellations and refunds of $3,664 and $3,404 in 1998 and 1997, respectively	$ 34,845	$ -	$ 33,409	$ -
Federal excise taxes	-	1,570	-	1,100
Salaries and other employee expenses	-	1,555	-	1,238
Travel and entertainment	-	822	-	736
Maintenance and supplies	-	359	-	405
Honoraria	-	248	-	252
Professional fees	-	284	-	253
Printing and design costs	-	108	-	156
Rent	-	123	-	141
Miscellaneous	-	70	-	120
Total expenses	$ 34,845	$ 5,139	$ 33,409	$ 4,401

9. Year 2000

The Year 2000 problem relates to the inability of information systems to properly recognize and process date-sensitive information beyond January 1, 2000. Many of the Fund's systems and related software are Year 2000 compliant and the Fund has a program in place designed to bring the remaining software and systems into Year 2000 compliance in time to minimize any detrimental effects on operations. The Fund has no internally generated programmed software coding to correct, as substantially all of the software utilized by the Fund is purchased or licensed from external providers. The estimated costs of these efforts to ensure that the programs and systems will be Year 2000 compliant are not expected to be material to the Fund's financial position or statement of activities.

SCHEDULE I: Statement of Award Transactions

Year Ended August 31, 1998
(All dollar amounts presented in thousands)

Unpaid awards, beginning of year	$ 40,043
Add - Awards granted (Schedule II)	38,943
	78,986
Less - Award payments made	(22,781)
Award cancellations (excluding refunds)	(3,577)
Net increase in unamortized discount	(435)
Unpaid awards, end of year	$ 52,193

SCHEDULE II: Statement of Awards Granted

Year Ended August 31, 1998

Schedule II information is included in the "Grants Index" beginning on page 44. The dollar amounts listed in this schedule reflect the actual dollar amounts (not rounded to thousands) approved and paid to awardees.

Grants Index

PROGRAM SUMMARY

	Approved*	Paid**
CAREER DEVELOPMENT OF SCIENTISTS		
Career Awards in the Biomedical Sciences	$ 13,719,200	$ 4,850,834
Hitchings-Elion Fellowships	1,475,623	1,305,668
Life Sciences Research Fellowships	369,000	339,000
Wellcome Research Travel Grants	335,069	299,365
Wellcome Trust Travel Grants	5,577	5,577
Other Grants	192,000	352,300
TOTAL	$ 16,096,469	$ 7,152,744
EMERGING INFECTIOUS DISEASES		
Scholar Awards in Molecular Parasitology	$ 1,200,000	$ 900,000
New Investigator Awards in Molecular Parasitology	975,000	747,500
New Initiatives in Malaria Research	750,000	825,000
Scholar Awards in Molecular Pathogenic Mycology	1,600,000	480,000
New Investigator Awards in Molecular Pathogenic Mycology	780,000	325,000
Other Grants	1,400,533	1,716,433
TOTAL	$ 6,705,533	$ 4,993,933
THERAPEUTIC SCIENCES		
Clinical Scientist Awards in Translational Research	$ 7,500,000	$ 750,000
New Investigator Awards in the Pharmacological or Toxicological Sciences	1,950,000	1,307,500
Scholar Awards in Experimental Therapeutics	-	840,000
Scholar Awards in Toxicology	-	725,000
Other Grants	896,717	357,017
TOTAL	$ 10,346,717	$ 3,979,517
REPRODUCTIVE SCIENCE		
Career Awards in the Biomedical Sciences	$ 825,000	224,950
Obstetrics and Gynecology Research Fellowships	144,000	92,000
Reproductive Scientist Development Program Research Grants	240,000	80,000
Other Grants	30,000	180,000
TOTAL	$ 1,239,000	$ 576,950

	Approved*	Paid**
INTERFACES BETWEEN THE PHYSICAL/CHEMICAL/ COMPUTATIONAL SCIENCES AND THE BIOLOGICAL SCIENCES		
Interfaces Programs	$ -	$ 1,948,375
Other Grants	426,500	251,500
TOTAL	$ 426,500	$ 2,199,875
SCIENCE EDUCATION		
Student Science Enrichment Program	$ 1,330,756	$ 1,501,291
Wellcome Visiting Professorships in the Basic Medical Sciences	165,000	140,000
Wellcome Visiting Professorships in the Microbiological Sciences	50,000	25,000
Other Grants	1,131,336	851,672
TOTAL	$ 2,677,092	$ 2,517,963
ENVIRONMENT FOR SCIENCE		
General	$ 945,450	$ 765,600
Communications	235,140	175,140
History of Medicine	269,000	152,000
Inactive Programs—Active Awardees of Former Programs	2,372	267,622
TOTAL	$ 1,451,962	$ 1,360,362
GRAND TOTALS	**$ 38,943,273**	**$ 22,781,344**

* **Approved**—Approved grants are expensed in the fiscal year in which the awards are granted, although the grants may be payable over several years.

** **Paid**—Paid grants represent actual cash outflows during the fiscal year.

Key to Grants Index—BWF makes all of its awards to nonprofit organizations. For most of the awards listed in the following sections, the individual on whose behalf an award was made is listed first, followed by the name of the awardee's institution, which received the money. For ad hoc awards, which are not made on behalf of an individual, the organization receiving the award is listed first. In all cases, if the actual payee for an award is different from the institutional recipient, the payee's name is listed second: for example, an award to the University of California-Berkeley, on behalf of an individual researcher, may be listed as having been paid to the Regents of the University of California.

Career Awards in the Biomedical Sciences

Note: Five additional career awards were made in reproductive science and are described in the "Reproductive Science" section.

** Career awards are postdoctoral-faculty bridging awards, and many recipients change institutions upon obtaining a faculty position. For these awardees, indicated with an asterisk, BWF cancels the original grant to the postdoctoral institution and makes a new grant for the remainder of the award to the current institution. In the descriptions below, the faculty-level grants are listed first and the canceled grants are listed second.*

Gregory J. Beitel, Ph.D.
Stanford University School of Medicine
Mechanisms that control and execute the cell movements and shape changes underlying metazoan morphogenesis
Paid $66,425

Mark Bix, Ph.D.
University of California-San Francisco School of Medicine
Regents of the University of California
Effector CD4+ T cell development: evidence for the stochastic generation and clonal distribution of a combinatorial cytokine repertoire
Paid $56,650

Edward S. Brodkin, M.D.
Princeton University
Trustees of Princeton University
Genetic analysis of anxiety-related behaviors in mice
Approved $532,400 Paid $27,500

Paul S. Buckmaster, D.V.M., Ph.D.
Stanford University School of Medicine
Mechanisms of temporal lobe epilepsy
Approved $357,500 Paid $121,000

David C. Chan, M.D., Ph.D.
Massachusetts Institute of Technology
Whitehead Institute for Biomedical Research
Structural and mechanistic studies of virus-mediated membrane fusion
Approved $470,800 Paid $27,500

Anita H. Corbett, Ph.D.
Emory University School of Medicine
Components of the nuclear transport system
Paid $118,250

Brendan P. Cormack, Ph.D.*
Johns Hopkins University School of Medicine
Virulence determinants of Candida glabrata
Approved $357,500 Paid $121,000
Stanford University School of Medicine
Paid $27,500

Jeanine D'Armiento, M.D., Ph.D.
Columbia University College of Physicians and Surgeons
Trustees of Columbia University
The role of matrix metalloproteinases in disease
Paid $118,250

George Q. Daley, M.D., Ph.D.
Massachusetts Institute of Technology
Whitehead Institute for Biomedical Research
Probing the pathogenesis of chronic myelogenous leukemia
Paid $29,150

Gregory C. DeAngelis, Ph.D.
Stanford University School of Medicine
Neural mechanisms underlying perceptual feature binding
Paid $56,650

Jeffrey S. Diamond, Ph.D.
Oregon Health Sciences University
Mechanisms underlying silent synapses: implications for synaptic plasticity in the hippocampus
Approved $470,800 Paid $27,500

Aaron DiAntonio, M.D., Ph.D.
University of California-Berkeley
Regents of the University of California
Genetic analysis of synapse formation, growth, and plasticity
Approved $470,800 Paid $27,500

Tamara L. Doering, M.D., Ph.D.
Cornell University Medical College
GPIs in fungi: biosynthesis and function
Paid $118,250

Michael J. Eck, M.D., Ph.D.
Harvard Medical School
Dana-Farber Cancer Institute
Structural analysis of protein interactions in signal transduction
Paid $117,250

Guowei Fang, Ph.D.
Harvard Medical School
President and Fellows of Harvard College
Mechanism of the spindle assembly checkpoint control
Approved $470,800 Paid $27,500

Steven Fiering, Ph.D.
Dartmouth Medical School
Trustees of Dartmouth College
Mutational analysis of the beta-globin locus control region by homologous recombination
Paid $118,250

Reiko Maki Fitzsimonds, Ph.D.
Yale University School of Medicine
Distributed properties of synaptic plasticity in neural networks
Approved $357,500

Catherine A. Fox, Ph.D.
University of Wisconsin-Madison Medical School
Board of Regents-University of Wisconsin
On the formation of domains of gene expression in eukaryotic chromosomes
Paid $118,250

Daved H. Fremont, Ph.D.
Columbia University
Trustees of Columbia University
Structural studies of antigen presentation and T cell activation
Paid $29,150

Jeffrey S. Glenn, M.D., Ph.D.
Stanford University School of Medicine
Prenylation and viral assembly
Approved $470,800 Paid $27,500

Joseph A. Gogos, M.D., Ph.D.
Columbia University College of Physicians and Surgeons
Trustees of Columbia University
Genetic analysis of connectivity in the mammalian olfactory system
Paid $56,650

Todd R. Golub, M.D.
Harvard Medical School
Dana-Farber Cancer Institute
Models for the molecular pathogenesis of human leukemia
Paid $117,250

Rachel Green, Ph.D.
Johns Hopkins University School of Medicine
Defining the peptidyl transferase center of the ribosome
Approved $357,500 Paid $121,000

Gyorgy Hajnoczky, M.D., Ph.D.
Thomas Jefferson University Jefferson Medical College
Control of cellular function by calcium oscillations
Paid $118,250

Carrie Haskell-Luevano, Ph.D.
Oregon Health Sciences University
Determination of the physiological and pharmacological role of the brain specific agouti-related transcript
Approved $470,800 Paid $27,500

Xianxin Hua, M.D., Ph.D.
Massachusetts Institute of Technology
Whitehead Institute for Biomedical Research
Identification and characterization of novel components in the TGF-β signaling pathway
Approved $532,400 Paid $27,500

Alan J. Hunt, Ph.D.*
University of Michigan
Regents of the University of Michigan
The role of microtubule dynamics in mitotic chromosome movement
Approved $357,500
University of Colorado
Paid $27,500

Jeffry S. Isaacson, Ph.D.
University of Washington School of Medicine
Biophysical properties of presynaptic terminals in the central nervous system
Paid $58,300

Raymond H. Jacobson, Ph.D.
University of California-Berkeley
Regents of the University of California
TBP-related factor and selectivity factor I: probing TBP function in alternative contexts
Paid $56,650

David K. R. Karaolis, Ph.D.
University of Maryland-Baltimore School of Medicine
Pathogenicity islands in the emergence of epidemic and pandemic cholera
Approved $412,500   Paid $27,500

Suzanne L. Kirby, M.D., Ph.D.
University of North Carolina-Chapel Hill School of Medicine
Proliferative advantage for therapeutic bone marrow
Paid $88,000

Scott C. Kogan, M.D.
University of California-San Francisco School of Medicine
Regents of the University of California
Use of a transgenic mouse model of acute promyelocytic leukemia to elucidate disease pathogenesis and to improve therapy
Paid $27,500

Margarethe J. Kuehn, Ph.D.
Duke University Medical Center
Secretory protein sorting in yeast and bacteria
Approved $357,500   Paid $121,000

Peter D. Kwong, Ph.D.
Columbia University College of Physicians and Surgeons
Trustees of Columbia University
An atomic-level investigation of the structure and associated biology of the HIV-coat protein, gp120
Approved $470,800   Paid $27,500

Jeh-Ping Liu, Ph.D.
Columbia University College of Physicians and Surgeons
Trustees of Columbia University
Molecular mechanisms in neural crest specification
Paid $39,750

Hiten D. Madhani, M.D., Ph.D.
Massachusetts Institute of Technology
Whitehead Institute for Biomedical Research
Specificity of signal transduction during dimorphic development of yeast
Approved $412,500   Paid $27,500

Zachary F. Mainen, Ph.D.
State University of New York-Stony Brook
Cold Spring Harbor Laboratory
Optical studies of synaptic plasticity mechanisms
Paid $56,650

Kelsey C. Martin, M.D., Ph.D.
Columbia University College of Physicians and Surgeons
Trustees of Columbia University
Communication between the synapse and the nucleus during long-lasting synaptic plasticity
Paid $56,650

Andrea I. McClatchey, Ph.D.
Harvard Medical School
General Hospital Corporation
The roles of the NF2 tumor suppressor gene product in embryogenesis and tumorigenesis
Approved $357,500   Paid $118,250

Robert Menard, M.D., Ph.D.
New York University Medical Center
Genetic analysis of malaria sporozoite virulence
Paid $60,500

Chandra Mohan, M.D., Ph.D.
University of Florida College of Medicine
B-cell tolerance and humoral autoimmunity
Approved $412,500   Paid $27,500

Louis J. Muglia, M.D., Ph.D.
Washington University School of Medicine
Adrenal and behavioral responses to stress
Paid $115,500

Charles E. Murry, M.D., Ph.D.
University of Washington School of Medicine
Muscle regeneration after myocardial infarction via gene therapy with MyoD
Paid $117,250

Inke S. Nathke, Ph.D.
University of Dundee
Role of APC/catenin complexes in colon cancer
Approved $357,500   Paid $60,500

James Olson, M.D., Ph.D.
University of Washington School of Medicine
Fred Hutchinson Cancer Research Center
NeuroD abrogation in neuroblastoma
Paid $56,650

Karen M. Ottemann, Ph.D.
University of California-Berkeley
Regents of the University of California
Chemotaxis in Helicobacter pylori *and its role in pathogenesis*
Approved $412,500   Paid $27,500

George A. Oyler, M.D., Ph.D.
Johns Hopkins University School of Hygiene and Public Health
Signaling pathways of neuronal apoptosis
Paid $119,250

Martin S. Pavelka Jr., Ph.D.
Albert Einstein College of Medicine
Biosynthesis of the mycobacterial cell wall
Paid $46,934

Martin R. Pollak, M.D.
Harvard Medical School
Brigham and Women's Hospital
Mouse molecular genetic studies of the extracellular Ca^{2+}-sensing receptor
Paid $27,500

Salman T. Qureshi, M.D.
McGill University Faculty of Medicine
Genetic analysis of innate resistance to bacterial pathogens
Approved $532,400 Paid $27,500

Ilaria Rebay, Ph.D.
Massachusetts Institute of Technology
Whitehead Institute for Biomedical Research
Investigation of yan function in Ras1-mediated signal transduction
Paid $118,250

David J. Robbins, Ph.D.
University of Cincinnati College of Medicine
Dissecting the hedgehog signal transduction pathway
Approved $357,500 Paid $60,500

Aimee K. Ryan, Ph.D.
University of California-San Diego
Regents of the University of California
Analysis of inductive events responsible for specification and differentiation of the anterior pituitary gland
Approved $470,800 Paid $27,500

Sylvia L. Sanders, Ph.D.
Massachusetts Institute of Technology
Analysis of cell-type differences in bud-site selection in Saccharomyces cerevisiae
Paid $116,750

Konstantin V. Severinov, Ph.D.
Rutgers, the State University of New Jersey
RNA polymerase and its subunits: structure and function
Paid $118,250

Judith A. Shizuru, M.D., Ph.D.
Stanford University School of Medicine
Transplantation of purified allogeneic hematopoietic stem cells: applications for transplantation tolerance induction and the treatment of autoimmune disease
Paid $118,250

Elaine K. Sia, Ph.D.
University of North Carolina-Chapel Hill
Analysis of yeast mutants with altered simple repeat stability
Approved $470,800 Paid $27,500

Upinder Singh, M.D.
University of Virginia Health Sciences Center
Transcriptional control in Entamoeba histolytica
Approved $532,400 Paid $27,500

Barry P. Sleckman, M.D., Ph.D.
Harvard Medical School
Center for Blood Research Inc.
Lineage specific regulation of T cell receptor beta rearrangement
Paid $49,325

Leonidas Stefanis, M.D.
Columbia University College of Physicians and Surgeons
Trustees of Columbia University
Proteases in neuronal cell death
Approved $357,500 Paid $60,500

David J. Sullivan Jr., M.D.
Johns Hopkins University School of Hygiene and Public Health
Iron metabolism in Plasmodium falciparum
Approved $357,500 Paid $121,000

Surachai Supattapone, M.D., D.Phil.
University of California-San Francisco School of Medicine
Regents of the University of California
The structure and biology of a soluble prion
Approved $470,800 Paid $27,500

Michael J. Thirman, M.D.
University of Chicago Medical Center
Functional analyses of the MLL-ELL fusion transcript in acute leukemia
Paid $119,250

Sarah A. Tishkoff, Ph.D.
Pennsylvania State University
Molecular sequence variation in G6PD and its role in malarial resistance
Approved $470,800 Paid $27,500

Katharine S. Ullman, Ph.D.
University of California-San Diego
Regents of the University of California
Biochemical dissection of RNA export using in vitro nuclear reconstitution
Paid $29,150

Peter C. VanBuren, M.D.
University of Vermont School of Medicine
Assessing the role of the thin filament in the altered contractility of heart failure
Paid $118,250

James A. Waddle, Ph.D.
Washington University School of Medicine
Generation of markers and methods to study asymmetric cell divisions in living Caenorhabditis elegans *embryos*
Paid $29,150

Johannes Walter, Ph.D.
University of California-San Diego
Regents of the University of California
Characterization of eukaryotic replication initiation factors using a soluble, cell-free system
Approved $470,800 Paid $27,500

William A. Weiss, M.D., Ph.D.
University of California-San Francisco School of Medicine
Regents of the University of California
A transgenic model for neuroblastoma
Paid $89,650

Ding Xue, Ph.D.
University of Colorado-Boulder
Biochemical analysis of CED-3/ICE cysteine proteases and their roles in apoptosis
Approved $357,500 Paid $121,000

Cassian Yee, M.D.
University of Washington School of Medicine
Fred Hutchinson Cancer Research Center Foundation
Adoptive immunotherapy of melanoma using T cells specific for potential tumor rejection antigens
Paid $30,800

John York, Ph.D.
Duke University Medical Center
Nuclear signal transduction: structure and function
Paid $117,250

SUBTOTAL
Approved $13,719,200 Paid $4,850,834

Hitchings-Elion Fellowships

Shawn C. Ahmed, Ph.D.
Medical Research Council
Genetics of germline immortality in Caenorhabditis elegans
Paid $24,500

Alison L. Barth, Ph.D.
University of Wales-Cardiff
The role of CREB in plasticity within adult somatosensory cortex
Paid $24,500

Catherine Baty, D.V.M., Ph.D.
University of Oxford
Feline familial hypertrophic cardiomyopathy: a natural model of human familial hypertrophic cardiomyopathy
Paid $49,000

Jill R. Beyette, Ph.D.
University of Cincinnati
Genomic molecular genetics of proteasomes
Approved $97,945 Paid $48,972

D. Scott Bohle, Ph.D.
University of East Anglia
Nitric oxide mediated iron depletion in bacteria
Approved $2,570

Elena S. Casey, Ph.D.
Medical Research Council
Defining the primary targets of Xbra, a transcription factor required for mesodermal patterning in Xenopus
Paid $24,500

David Cash, Ph.D.
Oregon State University
Morphological and molecular characterization of RA-induced and methoprene-induced deformities in Xenopus laevis *embryos*
Approved $49,905 Paid $49,905

Brian S. DeDecker, Ph.D.
University of Cambridge
Structure determination and thermodynamic analysis of mutant p53
Paid $49,000

Kevin S. Dingwell, Ph.D.
University of Cambridge
Role of N-cadherin in axon outgrowth
Approved $101,000 Paid $27,500

Francine Durocher, Ph.D.
University of Cambridge
Identifying common low penetrance genes and gene-environment interactions in breast cancer
Approved $101,000 Paid $27,500

Angela K. Eggleston, Ph.D.
Imperial Cancer Research Fund
Protein-protein interactions involved in holliday junction branch migration and resolution
Paid $4,088

John T. Finn, Ph.D.
University College London School of Medicine
Cell-cycle control of cell number in the retina
Paid $49,000

FenBiao Gao, Ph.D.
University of California-San Francisco
Regents of the University of California
The control mechanism of oligodendrocyte development in the rodent optic nerve
Approved $52,808 Paid $52,808

M. Valerie Gremillion, Ph.D.
University of Oxford
Realistic computational modeling of the early visual pathway
Approved $3,106 Paid $27,606

Reuben S. Harris, Ph.D.
Medical Research Council
Delineation of the mechanism of immunoglobulin gene hypermutation
Approved $101,000 Paid $27,500

Susan C. Hockings, Ph.D.
University of Leicester
Mechanism of DNA cleavage by DNA gyrase
Approved $101,000 Paid $27,500

Kenneth A. Johnson, Ph.D.
University of York
Laue diffraction studies on crystals of unliganded r-state hemoglobin
Paid $49,000

Perry M. Kirkham, Ph.D.
University of Alabama-Birmingham
Electrostatic design of combinatorial antibody libraries
Approved $70,774 Paid $70,774

Kenro Kusumi, Ph.D.
Medical Research Council
Genetic analysis of Hox *regulation in paraxial mesoderm*
Approved $101,000 Paid $27,500

Jacqueline L. S. Milne, Ph.D.
Medical Research Council
Structural studies of seven helix cAMP receptors by electron cryo-microscopy
Paid $49,000

Raymond T. O'Keefe, Ph.D.
University of Manchester
Molecular mechanisms in pre-mRNA splicing
Approved $49,000 Paid $49,000

Stephen C. Ogg, Ph.D.
University of Dundee
Intranuclear transport: factors required for correct subnuclear compartmentalization
Paid $49,000

David D. Pollock, Ph.D.
University of California-Berkeley
Regents of the University of California
Relationships between the structural context of individual amino acid sites in proteins and the evolutionary patterns of substitution which have developed
Approved $52,129 Paid $52,129

Jill Rafael, Ph.D.
University of Oxford
The role of utrophin and dystrophin in skeletal muscle and non-muscle tissues
Paid $49,000

Laura Rosa Brunet, D.Sc.
University of Cambridge
The role of inflammatory cytokines in the pathogenesis of murine schistosomiasis
Approved $101,000

Michael J. Schell, Ph.D.
University of Cambridge
Brain calcium homeostasis: functional roles of GAP1-IP4BP
Paid $52,000

Kristin C. Scott, Ph.D.
Medical Research Council
Ectopic silencing in fission yeast
Approved $101,000 Paid $27,500

Steven P. Smith, Ph.D.
University of Oxford
Interactions of granulocyte-colony-stimulating factor with its receptor at the molecular level
Approved $101,000 Paid $27,500

Dean G. Tang, M.D., Ph.D.
University College London
Role of cell cycle components in timing the oligodendrocyte precursor cell differentiation and senescence
Approved $101,000 Paid $27,500

Joseph Terwilliger, Ph.D.
Columbia University
Trustees of Columbia University
Mathematical analysis of complex disease
Approved $35,765 Paid $35,765

Anthony Varghese, Ph.D.
University of Minnesota
Mathematical modeling of effects of antiarrhythmic drugs
Approved $51,621 Paid $51,621

Angela J. Villar, Ph.D.
University of California-San Francisco
Regents of the University of California
Allele-specific expression of Igf-2 and H19 during mouse gametogenesis
Paid $49,000

Yimin Wu, Ph.D.
University of Oxford
Protein sorting signals in the human malaria parasite Plasmodium falciparum
Paid $24,500

Lori M. Zeltser, Ph.D.
King's College London
Guy's Hospital
Molecular interactions in patterning and boundary formation in the chick diencephalon
Paid $49,000

Michael E. Zuber, Ph.D.
University of Cambridge
Molecular and cellular interactions required for vertebrate eye field formation
Approved $101,000 Paid $52,000

SUBTOTAL
Approved $1,475,623 Paid $1,305,668

Life Sciences Research Fellowships

These fellowships are administered in partnership with the Life Sciences Research Foundation. BWF awards the primary grant to the foundation, which distributes the funds to the individual awardees.

John A. Berglund, Ph.D. (1998-2001)
University of Colorado-Boulder
Structural studies on the RNA binding protein BBBp and its substrate RNA
Approved $123,000 Paid $41,000

Michael Brainard, Ph.D. (1996-99)
University of California-San Francisco
Neural and behavioral analysis of vocal learning
Paid $36,000

Enrique M. De La Cruz, Ph.D. (1998-2001)
University of Pennsylvania School of Medicine
Molecular mechanism of myosin 1
Approved $123,000 Paid $41,000

Marilyn Diaz, Ph.D. (1997-2000)
University of Miami School of Medicine
Do shark lymphocytes bear a single type of antigen receptor?
Paid $36,000

Andrew Dittman, Ph.D. (1997-2000)
University of California-Berkeley
Isolation and analysis of goldfish pheromone receptors
Paid $36,000

Jenny Gumperz, Ph.D. (1996-99)
Harvard Medical School
T cell recognition of mycobacterial antigens presented by CD1 molecules
Paid $36,000

Mary Ellen Lane, Ph.D. (1998-2001)
Massachusetts Institute of Technology
Whitehead Institute for Biomedical Research
Analysis of posterior neural development
Approved $123,000 Paid $41,000

Jeannine M. Petersen, Ph.D. (1997-2000)
University of Wisconsin-Madison School of Medicine
Understanding mechanisms and control of the nuclear transport pathway
Paid $36,000

Joseph Wedekind, Ph.D. (1996-99)
Stanford University Medical Center
The structural basis of catalysis for a hammerhead ribozyme
Paid $36,000

SUBTOTAL
Approved $369,000 Paid $339,000

Wellcome Research Travel Grants

** Grants are related to history of medicine.*

Note: Beginning with the 2000 award series, the program name is changed to BWF Research Travel Grants.

Ellen L. Aho, Ph.D.
Concordia College
The role of class II pili in the pathogenesis of Neisseria meningitidis
Approved $8,150 Paid $8,150

Philip W. Askenase, M.D.
Yale University School of Medicine
The role of Th2 T cell cutaneous basophil hypersensitivity in bronchial asthma
Approved $13,000 Paid $13,000

Homer S. Black, Ph.D.
Baylor College of Medicine
Identification and evaluation of carotenoid radical interception properties: prerequisite studies for anti-carcinogenesis evaluation
Approved $5,638 Paid $5,638

Bernd U. Budelmann, Ph.D.*
University of Texas Medical Branch-Galveston
Transfer of Professor John Z. Young's collection of cephalopod brain slides from England to the Smithsonian Museum of Natural History
Approved $7,500 Paid $7,500

Arvil W. Burks, M.D.
University of Arkansas for Medical Sciences
Molecular and immunologic mechanisms in peanut allergen recognition and immunotherapy
Approved $6,000 Paid $6,000

George Carayanniotis, Ph.D.
Memorial University of Newfoundland
Development of animal model for Graves' disease
Approved $5,310 Paid $5,310

Robert A. Colbert, M.D., Ph.D.
University of Cincinnati
Children's Hospital Medical Center
Role of interferon-alpha inducible subunits in the generation of MHC class I epitopes by proteasomes
Approved $5,650 Paid $5,650

Richard W. Compans, Ph.D.
Emory University School of Medicine
Cell biology of filamentous influenza virus
Approved $14,060 Paid $14,060

Mary F. Dallman, Ph.D.
University of California-San Francisco
Neuroanatomical mechanisms underlying physiological and behavioral alterations produced by exposure to chronic stress
Approved $6,700 Paid $6,700

Philip J. Davis, Ph.D.
Memorial University of Newfoundland
Study of the effect of marine mammal oil on lipoproteins in hamster
Approved $3,750 Paid $3,750

Lloyd Demetrius, Ph.D.
Massachusetts Institute of Technology
Relationship between protein structure and conformational dimension of the folded state
Approved $10,700

Lloyd Demetrius, Ph.D.
Massachusetts Institute of Technology
Thermodynamics and kinetics of protein folding
Approved $12,250 Paid $12,250

Timothy D. Dye, Ph.D.
University of Rochester
Neonatal intensive care and infant mortality in Northern Ireland
Approved $4,550 Paid $4,550

William H. Feindel, M.D., D.Phil.*
McGill University Faculty of Medicine
Wilder Penfield's idea of a neurological institute: the influence of Oxford and Queen Square
Approved $4,765 Paid $4,765

Jay W. Fox, Ph.D.
University of Virginia Health Sciences Center
Venom metalloproteinases
Approved $3,802 Paid $3,802

David Heeley, Ph.D.
Memorial University of Newfoundland
Consequences of sequence heterogeneity and phosphorylation on the biochemical properties of thin filament proteins using an in vitro motility assay
Approved $2,929 Paid $2,929

W. Reuben Kaufman, Ph.D.
University of Alberta
Role of tick salivary glands in transmission of arboviruses: the capture and secretion of host immunoglobulins and cytokines
Approved $11,975   Paid $11,975

Paul E. Kopperman, Ph.D.*
Oregon State University
Theory and practice in 18th-century British medicine
Approved $1,500   Paid $1,500

Ruben I. Kuzniecky, M.D.
University of Alabama-Birmingham
Malformations of brain development: metabolic and functional reorganization studied by magnetic resonance
Approved $10,000

May H. Lesser*
Tulane University School of Medicine
A study of the surgeon who performed the first liver transplantation in the United Kingdom
Approved $3,318   Paid $3,318

Brian Leyland-Jones, M.D.
McGill University
The identification of genes involved in resistance to commonly used antitumor agents and novel antitumor drugs
Approved $5,650   Paid $5,650

Joseph T. McCabe, Ph.D.
Uniformed Services University of the Health Sciences
Physiological activation of Egr-1 and WT1 expression in hypothalamic neurons
Approved $6,000   Paid $6,000

Rose M. McMurphy, D.V.M.
Kansas State University
The use of transesophageal echocardiography in anesthetized horses to evaluate the effects of dobutamine infusion for treatment of hypotension
Approved $4,148   Paid $4,148

Marvin L. Meistrich, Ph.D.
University of Texas
Measuring induced mutations by PCR analysis of sperm
Approved $10,280

Douglas K. Mitchell, M.D.
Eastern Virginia Medical School
Technological transfer of techniques for the study of astrovirus infections in children
Approved $6,000   Paid $6,000

T. J. Murray, M.D.*
Dalhousie University Faculty of Medicine
The biography of a disease: the history of multiple sclerosis
Approved $5,400   Paid $5,400

Felicia V. Nowak, M.D., Ph.D.
Saint Louis University Health Sciences Center
Subcellular localization of the preoptic regulatory peptides
Approved $7,024

Elizabeth M. Petty, M.D.
University of Michigan School of Medicine
Regents of the University of Michigan
Characterization of a novel breast and ovarian cancer gene
Approved $2,500   Paid $2,500

Joseph R. Pisegna, M.D.
University of California-Los Angeles School of Medicine
Regents of the University of California
Characterization of the signal transduction, internalization, and desensitization of the human pituitary adenylate cyclase activating polypeptide receptor
Paid $5,800

Derrick E. Rancourt, Ph.D.
University of Calgary
Mouse models of retinal disease for gene therapy
Approved $3,000   Paid $3,000

Kevin D. Raney, Ph.D.
University of Arkansas for Medical Sciences
Enzymology and inhibition of telomerase: a unique enzyme implicated in progression of cancer
Approved $3,100   Paid $3,100

Lynne J. Regan, Ph.D.
Yale University
Structural studies of natural and designed proteins and protein-protein interactions
Approved $14,764   Paid $14,764

David M. Rodman, M.D.
University of Colorado Health Sciences Center
Gene transfer in experimental pulmonary hypertension
Paid $5,500

Barry P. Rosen, Ph.D.
Wayne State University School of Medicine
Catalytic mechanism of a resistance ATPase
Paid $6,000

Aryeh Routtenberg, Ph.D.
Northwestern University
Synaptic plasticity and neurotransmitter release: gain-of-function in transgenic mouse over expressing the growth-associated, neuro-specific protein GAP-43
Approved $8,700 Paid $8,700

Aleem Siddiqui, Ph.D.
University of Colorado Health Sciences Center
Role of hepatitis B virus x protein in DNA repair
Approved $8,450 Paid $8,450

Mark E. Silverman, M.D.*
Emory University School of Medicine
Paul Wood: his life and influence on cardiology
Approved $15,000 Paid $15,000

Richard B. Simerly, Ph.D.
Oregon Health Sciences University
Development of neuroendocrine connections: new experimental approaches in transgenic mice
Approved $8,000 Paid $8,000

Joan L. Sobel, Ph.D.
Columbia University College of Physicians and Surgeons
Trustees of Columbia University
The influence of genotype on fibrinogen structure and function: studies of the A alpha 312 polymorphism
Approved $2,850 Paid $2,850

Fred J. Spielman, M.D.*
University of North Carolina-Chapel Hill School of Medicine
North Carolina Medical Foundation-Anesthesiology
The history of pain control through art
Approved $3,850 Paid $3,850

Victoria Sweet, M.D.*
University of California-San Francisco School of Medicine
Regents of the University of California
Hildegard of Bingen: transformative versus mechanistic models of disease
Approved $5,100 Paid $5,100

Barbara J. Taylor, Ph.D.
Oregon State University
Physiology of sex specific neurons in Drosophila
Approved $13,775 Paid $13,775

E. Brad Thompson, M.D.
University of Texas Medical Branch-Galveston
Studies of the anti-leukemic cell activity of a human glucocorticoid receptor fragment
Approved $11,000 Paid $11,000

Stephen F. Traynelis, Ph.D.
Emory University
The role of kainate receptors in excitatory synaptic transmission in the cerebellum
Approved $7,100 Paid $7,100

Nancy Van Houten, Ph.D.
University of Texas Medical Branch-Galveston
Mechanisms of oral tolerance induction
Approved $3,707 Paid $3,707

Harry V. Vinters, M.D.
University of California-Los Angeles School of Medicine
Regents of the University of California
Molecular pathogenesis of mitochondrial muscle disease
Approved $5,400 Paid $5,400

Samuel Weiss, Ph.D.
University of Calgary Faculty of Medicine
POU-III gene function in zebrafish neural development
Approved $15,000

George Weisz, Ph.D.*
McGill University
Medical specialization in Britain during the 19th and 20th centuries
Approved $6,185 Paid $6,185

Christopher Whitfield, Ph.D.
University of Guelph
Pathways and enzymes for the export of bacterial capsular polysaccharides
Approved $2,950 Paid $2,950

Kirk Willis, Ph.D.*
University of Georgia
The Atomic Scientists' Association and the biological hazards of atomic energy, 1946-59
Approved $2,589 Paid $2,589

Warren Winkelstein, M.D.*
University of California-Berkeley
Regents of the University of California
Life and work of Janet Lane-Claypon: pioneer epidemiologist and advocate for women's and children's health
Approved $6,000 Paid $6,000

SUBTOTAL
Approved $335,069 Paid $299,365

Wellcome Trust Travel Grants

These grants are made by the Wellcome Trust, BWF's sister philanthropy in the United Kingdom, to support visits by U.K. and Irish researchers to the United States. BWF makes grants to the host institutions as a contribution to expenses incurred during the visit.

Harvard Medical School
S. K. Srai
Royal Free Hospital School of Medicine
DCT1 expression under differing body iron status
Approved $1,000 Paid $1,000

Johns Hopkins University School of Medicine
Fernando Schlindwein
University of Leicester
Variability of the heart's rhythm during brain trauma
Approved $1,000 Paid $1,000

Medical University of South Carolina
Keith R. Williams
University of Wales
Finite element analysis of biomedical problems
Approved $1,000 Paid $1,000

University of California-Davis
Polly M. Taylor
University of Cambridge
The mechanisms of opioid-induced excitement in the horse
Approved $1,000 Paid $1,000

University of California-Irvine
R. F. Halliwell
University of Durham
How endogenous and exogenous agents modulate ion channel activity
Approved $1,000 Paid $1,000

University of Rhode Island
H. Huddart
Lancaster University
Control systems in buccal muscles of marine mollusks
Approved $577 Paid $577

SUBTOTAL
Approved $5,577 Paid $5,577

Other Grants

In addition to its competitive awards, BWF makes noncompetitive grants for activities that are closely related to its major focus areas. These grants are intended to enhance the general environment for research in the targeted areas.

American Association for the Advancement of Science
Support for Science's Next Wave*, a web-based resource for young scientists*
Approved $187,000 Paid $187,000

Commission on Professionals in Science and Technology
Support for survey of opportunities for recent doctorates in biochemistry and molecular biology
Paid $50,000

Harvard Medical School
Support for scientific and professional career development mentoring
Approved $5,000 Paid $5,000

Radcliffe College
Support for biomedical fellowships for postdoctoral women scientists
Paid $110,300

SUBTOTAL
Approved $192,000 Paid $352,300

TOTAL CAREER DEVELOPMENT OF SCIENTISTS

Approved $16,096,469 Paid $7,152,744

Scholar Awards in Molecular Parasitology

Norma W. Andrews, Ph.D.
Yale University School of Medicine
The role of lysosome exocytosis in the cell invasion mechanism of Trypanosoma cruzi
Approved $400,000 Paid $20,000

Bruce M. Christensen, Ph.D.
University of Wisconsin-Madison
Board of Regents-University of Wisconsin
Cellular, biochemical, and molecular mechanisms that control compatibility/incompatibility of mosquito vectors for the parasites they transmit
Paid $60,000

Daniel Goldberg, M.D., Ph.D.
Washington University School of Medicine
Hemoglobin metabolism in Plasmodium falciparum
Paid $80,000

Anthony A. James, Ph.D.
University of California-Irvine
Regents of the University of California
Reduction of the transmission of vector-borne diseases by genetic manipulation of vector arthropods
Paid $80,000

Patricia J. Johnson, Ph.D.
University of California-Los Angeles School of Medicine
Regents of the University of California
Investigation of potential chemotherapeutic targets and the pathogenesis of the human-infective parasite Trichomonas vaginalis
Approved $400,000 Paid $20,000

Keith A. Joiner, M.D.
Yale University School of Medicine
A molecular analysis of secretion in Toxoplasma gondii
Paid $80,000

Scott M. Landfear, Ph.D.
Oregon Health Sciences University School of Medicine
Biology of membrane transporters in Leishmania *parasites*
Paid $80,000

James H. McKerrow, M.D., Ph.D.
University of California-San Francisco School of Medicine
Regents of the University of California
Parasite proteases: analysis of structure-function relationships and structure-based drug design
Paid $80,000

William Petri Jr., M.D., Ph.D.
University of Virginia Health Sciences Center
Adherence and cytolysis by Entamoeba histolytica
Paid $80,000

David S. Roos, Ph.D.
University of Pennsylvania
Trustees of the University of Pennsylvania
Exploring the function of the apicomplexan plastid
Approved $400,000 Paid $20,000

David G. Russell, Ph.D.
Washington University School of Medicine
Molecular mechanisms employed by Leishmania *and* Mycobacterium *to ensure their continued success as intramacrophage parasites*
Paid $80,000

Rick L. Tarleton, Ph.D.
University of Georgia
University of Georgia Research Foundation
Immunity and disease in Trypanosoma cruzi *infection*
Paid $80,000

Buddy Ullman, Ph.D.
Oregon Health Sciences University School of Medicine
Oregon Health Sciences Foundation
Chemotherapy and drug resistance in the parasitic protozoa Leishmania *and* Trypanosoma
Paid $60,000

Elisabetta Ullu, Ph.D.
Yale University School of Medicine
A molecular analysis of the nucleus in Trypanosoma brucei
Paid $80,000

SUBTOTAL
Approved $1,200,000 Paid $900,000

New Investigator Awards in Molecular Parasitology

John H. Adams, Ph.D.
University of Notre Dame
Molecular analysis of the malaria merozoite apical complex
Paid $65,000

James D. Bangs, Ph.D.
University of Wisconsin-Madison Medical School
Board of Regents-University of Wisconsin
Secretory and endocytic trafficking in Trypanosoma brucei
Paid $65,000

Cornelis J. Beckers, Ph.D.
University of Alabama-Birmingham School of Medicine
The role of cytoplasmic calcium in the regulation of motility and host cell invasion by Toxoplasma gondii
Approved $195,000 Paid $32,500

Vivian M. Bellofatto, Ph.D.
University of Medicine and Dentistry of New Jersey-New Jersey Medical School
Molecular analysis of trypanosome gene transcription
Approved $195,000 Paid $32,500

James P. Bruzik, Ph.D.
Case Western Reserve University
Examination of the role of protein factors in trans-splicing in nematodes and trypanosomatids
Paid $32,500

Christopher A. Hunter, Ph.D.
University of Pennsylvania School of Veterinary Medicine
Role of accessory molecules in the regulation of natural killer responses during infection
Paid $65,000

Stuart J. Kahn, M.D.
University of Washington School of Medicine
The analysis of the naive T cell response to the surface glycoprotein superfamily of Trypanosoma cruzi
Approved $195,000 Paid $32,500

Kami Kim, M.D.
Albert Einstein College of Medicine
Signaling pathways and Toxoplasma gondii *differentiation*
Approved $195,000 Paid $32,500

Jonathan H. LeBowitz, Ph.D.
Purdue University
Purdue Research Foundation
Structure and function of the Leishmania *paraflagellar rod*
Paid $65,000

Dmitri A. Maslov, Ph.D.
University of California-Riverside
Regents of the University of California
Regulation of gene expression in the kinetoplast of trypanosomatid protozoa
Paid $32,500

Martin Olivier, Ph.D.
Laval University Faculty of Medicine
Role of the macrophage protein tyrosine phosphatase SHP-1 in Leishmania *pathogenesis*
Approved $195,000 Paid $32,500

Marc Ouellette, Ph.D.
Laval University Faculty of Medicine
Drug resistance mechanisms in Leishmania
Paid $65,000

Eric Pearlman, Ph.D.
Case Western Reserve University School of Medicine
Cell recruitment in helminth-induced allergic inflammation
Paid $65,000

Margaret A. Phillips, Ph.D.
University of Texas Southwestern Medical Center-Dallas
Selection of peptides which inhibit parasite ornithine decarboxylases
Paid $32,500

Laurie K. Read, Ph.D.
State University of New York-Buffalo
Research Foundation of SUNY
Mitochondrial RNA processing in Trypanosoma brucei
Paid $65,000

Steven L. Reiner, M.D.
University of Chicago Pritzker School of Medicine
Parasite-specific transgenic mice and the genetic control of leishmaniasis
Paid $32,500

SUBTOTAL
Approved $975,000 Paid $747,500

New Initiatives in Malaria Research

David J. Bzik, Ph.D.
Dartmouth Medical School
Trustees of Dartmouth College
Positive and negative genetic selection in Plasmodium
Approved $50,000   Paid $50,000

Jonathan A. Ellman, Ph.D.
University of California-Berkeley
Irwin D. Kuntz, Ph.D.
University of California-San Francisco School of Pharmacy
Regents of the University of California
Inhibitors of plasmepsin II for malaria treatment
Paid $100,000

Channe D. Gowda, Ph.D.
Georgetown University Medical Center
Christian Ockenhouse, M.D., Ph.D.
Walter Reed Army Institute of Research
Georgetown University
Maternal malaria and chondroitin sulfate proteoglycans of human placenta
Approved $100,000   Paid $50,000

Kasturi Haldar, Ph.D.
Stanford University School of Medicine
Secretory targeting signals in Plasmodia
Paid $100,000

James W. Kazura, M.D.
Case Western Reserve University School of Medicine
Nicholas Schork, Ph.D.
Case Western Reserve University
Genetic dissection of malaria morbidity
Paid $100,000

Donald J. Krogstad, M.D.
Tulane University Medical Center
Frank B. Cogswell, Ph.D.
Tulane Regional Primate Research Center
Tulane University
Aminoquinolines active against drug-resistant Plasmodium falciparum
Paid $75,000

Victor Nussenzweig, M.D.
New York University Medical Center
Ruth Nussenzweig, M.D., Ph.D.
New York University Medical Center
The function of sporozoite membrane proteins investigated in genetically engineered malaria parasites
Paid $100,000

Michael C. Pirrung, Ph.D.
Duke University
Alvin L. Crumbliss, Ph.D.
Duke University
Orally available iron chelators as antimalarials
Approved $100,000   Paid $50,000

Pradipsinh K. Rathod, Ph.D.
Catholic University of America
Accelerated drug resistance in Plasmodium falciparum
Paid $100,000

Mary M. Stevenson, Ph.D.
McGill University Faculty of Medicine
Philippe Gros, Ph.D.
McGill University Faculty of Medicine
Montreal General Hospital Research Institute
Genetic and functional dissection of susceptibility to malaria
Approved $400,000   Paid $50,000

Liangbiao Zheng, Ph.D.
Yale University School of Medicine
Positional approach to clone Pen1 *from* Anopheles gambiae
Approved $100,000   Paid $50,000

SUBTOTAL
Approved $750,000   Paid $825,000

Scholar Awards in Molecular Pathogenic Mycology

Judith Berman, Ph.D.
University of Minnesota
Use of Saccharomyces cerevisiae *to study molecular mechanisms of* Candida albicans *pathogenicity*
Paid $80,000

William A. Fonzi, Ph.D.
Georgetown University
Environmental signals and virulence of Candida albicans
Paid $80,000

William E. Goldman, Ph.D.
Washington University School of Medicine
Probing the parasitic lifestyle of Histoplasma capsulatum
Paid $80,000

Joseph Heitman, M.D., Ph.D.
Duke University Medical Center
Signal transduction pathways regulating virulence of Cryptococcus neoformans
Approved $400,000 Paid $20,000

Elizabeth J. Keath, Ph.D.
Saint Louis University
Novel molecular and DNA vaccine approaches to Histoplasma capsulatum
Approved $400,000 Paid $20,000

Bruce Klein, M.D.
University of Wisconsin-Madison Medical School
Board of Regents-University of Wisconsin
Genetic immunization against pathogenic fungi
Paid $80,000

Stuart M. Levitz, M.D.
Boston University School of Medicine
Boston Medical Center
Use of molecular biology to identify Cryptococcus neoformans *antigens that stimulate cell-mediated immunity*
Approved $400,000 Paid $20,000

Aaron P. Mitchell, Ph.D.
Columbia University College of Physicians and Surgeons
Trustees of Columbia University
Analysis of the Candida *CaRIM transduction pathway*
Paid $80,000

Peter A. B. Orlean, Ph.D.
University of Illinois-Urbana-Champaign
Board of Trustees of the University of Illinois
Glycolipid anchoring of protein and wall biogenesis in fungal pathogens
Approved $400,000 Paid $20,000

SUBTOTAL
Approved $1,600,000 Paid $480,000

New Investigator Awards in Molecular Pathogenic Mycology

Kent L. Buchanan, Ph.D.
University of Oklahoma Health Sciences Center
Acquired host resistance in cryptococcal meningitis
Approved $195,000 Paid $32,500

Gary B. Huffnagle, Ph.D.
University of Michigan Medical Center
Regents of the University of Michigan
The role of melanin production by Cryptococcus neoformans *in evasion of host defenses*
Approved $195,000 Paid $32,500

Haoping Liu, Ph.D.
University of California-Irvine College of Medicine
Regents of the University of California
Regulation of dimorphism in Candida albicans
Paid $65,000

Jennifer K. Lodge, Ph.D.
Saint Louis University School of Medicine
Identification of virulence-related determinants in Cryptococcus neoformans
Approved $195,000 Paid $32,500

Michelle C. Momany, Ph.D.
University of Georgia
University of Georgia Research Foundation
Identification of novel cell wall components in Aspergillus fumigatus
Paid $65,000

Theodore C. White, Ph.D.
University of Washington School of Public Health and Community Medicine
Seattle Biomedical Research Institute
Transcriptional regulation of drug resistance in Candida albicans
Paid $65,000

Brian L. Wickes, Ph.D.
University of Texas Health Science Center-San Antonio
Identification of mating type-associated antifungal targets in Cryptococcus neoformans
Approved $195,000 Paid $32,500

SUBTOTAL
Approved $780,000 Paid $325,000

Other Grants

In addition to its competitive awards, BWF makes noncompetitive grants for activities that are closely related to its major focus areas. These grants are intended to enhance the general environment for research in the targeted areas.

American Physiological Society
Support for Genomics to Physiology and Beyond: How Do We Get There conference
Approved $10,000 Paid $10,000

American Society for Microbiology
Support for medical mycology activities at society's annual meeting
Approved $5,050 Paid $5,050

American Society of Tropical Medicine and Hygiene
Support for bioinformatics workshop at society's 1998 annual meeting
Approved $50,000

American Society of Tropical Medicine and Hygiene
Support for society's 1997 annual meeting
Approved $15,000 Paid $15,000

American Society of Tropical Medicine and Hygiene
Support for society's 1998 annual meeting
Approved $23,400 Paid $23,400

Centers for Disease Control and Prevention
CDC Foundation
Support for International Conference on Emerging Diseases
Paid $5,000

Cornell University
Support for Woods Hole Immunoparasitology Meeting
Approved $10,000 Paid $10,000

FASEB Summer Research Conference
Support for Microbial Pathogenesis: Mechanisms of Infectious Diseases conference
Approved $7,500 Paid $7,500

Fourth International Conference on *Cryptococcus* and Cryptococcosis
Support for young investigators to attend conference
Approved $10,000 Paid $10,000

Georgetown University Medical Center
Support for Fifth International Meeting on Candida *and Candidiasis*
Approved $10,000

Gordon Research Conferences
Support for conference on malaria
Approved $25,000 Paid $25,000

Infectious Diseases Society of America
Support for Vaccine Initiative
Approved $20,000 Paid $20,000

Institute for Genomic Research
Support for continuation of sequencing of chromosome 14 of Plasmodium falciparum
Approved $500,000 Paid $500,000

International Eye Foundation
Support for multicenter study of ocular pathology in severe malaria
Paid $65,900

Keystone Symposia
Support for Toward the Genetic Manipulation of Insects symposium
Paid $5,000

Keystone Symposia
Support for Type 2 Cytokines in Allergy and Helminth Infections symposium
Approved $5,000 Paid $5,000

Marine Biological Laboratory
Support for Biology of Parasitism training course
Paid $50,000

Marine Biological Laboratory
Support for Molecular Mycology training course
Paid $100,000

National Institute of Allergy and Infectious Diseases
Foundation for Advanced Education
Support for Biology of Parasitic Infection lecture series
Approved $5,000 Paid $5,000

National Institutes of Health
Foundation for Advanced Education
Support for a predoctoral researcher at the National Center for Biotechnology Information to perform Plasmodium falciparum *genome analysis and to develop web-based tools for the malaria community*
Approved $21,083 Paid $21,083

New York University School of Medicine
Support for continuation of optical mapping of the Plasmodium falciparum *genome*
Approved $120,000 Paid $120,000

Sixth International Mycological Congress
Support for congress
Approved $5,000 Paid $5,000

Smith College
Support for Evolutionary Relationships among Eukaryotes symposium
Approved $2,500 Paid $2,500

Stanford University School of Medicine
Support for sequencing the Candida albicans *genome*
Paid $150,000

Stanford University School of Medicine
Stanford University DNA Sequencing and Technology Center
Support for Malaria Genome Project: large-scale sequencing of chromosome 12 of Plasmodium falciparum
Approved $500,000 Paid $500,000

Task Force for Child Survival and Development
Support for Global Disease Elimination and Eradication as Public Health Strategies conference
Approved $10,000 Paid $10,000

University of Alabama-Birmingham
Support for Trypanosoma *and* Leishmania: *Their Contributions to the Understanding of Biology symposium*
Approved $1,000 Paid $1,000

University of Georgia
University of Georgia Research Foundation Inc.
Support for meeting on genomic and post genomic/functional genomics analysis of Trypanosoma cruzi
Approved $15,000 Paid $15,000

University of Michigan
Support for Midwest Microbial Pathogenesis Meeting
Approved $1,000 Paid $1,000

University of Virginia
Support for meeting to organize the Entamoeba histolytica *genome project*
Approved $5,000 Paid $5,000

University of Virginia School of Medicine
Support for parasitology research grant on behalf of Dr. Joel Hockensmith
Approved $20,000 Paid $20,000

Washington University
Support for Midwest Microbial Pathogenesis Meeting
Approved $4,000 Paid $4,000

SUBTOTAL
Approved $1,400,533 Paid $1,716,433

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TOTAL EMERGING INFECTIOUS DISEASES

Approved $6,705,533 Paid $4,993,933

THERAPEUTIC SCIENCES

Clinical Scientist Awards in Translational Research

Gilbert Chu, M.D., Ph.D.
Stanford University Medical Center
Cancer treatment by genome-wide transcription scanning
Approved $750,000 Paid $75,000

Claire M. Doerschuk, M.D.
Harvard School of Public Health
The response of neutrophils during inflammatory lung disease
Approved $750,000 Paid $75,000

Robert W. Doms, M.D., Ph.D.
University of Pennsylvania School of Medicine
Chemokine receptors as new targets for HIV-1 therapeutics
Approved $750,000 Paid $75,000

Erol Fikrig, M.D.
Yale University School of Medicine
Borrelia *gene expression and lyme arthritis*
Approved $750,000 Paid $75,000

Alex E. MacKenzie, M.D., Ph.D.
University of Ottawa Faculty of Medicine
The cytoprotective NAIP and XIAP genes: identification of activation pathways and inducing agents
Approved $750,000 Paid $75,000

Howard A. Rockman, M.D.
University of North Carolina-Chapel Hill School of Medicine
Novel molecular therapeutic strategies in heart failure: role of beta-adrenergic receptor desensitization
Approved $750,000 Paid $75,000

Christian W. Schindler, M.D., Ph.D.
Columbia University College of Physicians and Surgeons
Trustees of Columbia University
Intervention of IL-5 signaling: a therapeutic paradigm for asthma
Approved $750,000 Paid $75,000

Joyce M. Slingerland, M.D., Ph.D.
University of Toronto Faculty of Medicine
Resistance to tamoxifen: a consequence of altered p27^{Kip1} regulation during breast cancer progression
Approved $750,000 Paid $75,000

Mark J. Yeager, M.D., Ph.D.
Scripps Research Institute
Structure and function of cardiac gap junction membrane channels
Approved $750,000 Paid $75,000

Hagop Youssoufian, M.D.
Baylor College of Medicine
Transcellular gene therapy: application to Fanconi anemia
Approved $750,000 Paid $75,000

SUBTOTAL
Approved $7,500,000 Paid $750,000

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New Investigator Awards in the Pharmacological or Toxicological Sciences

Pharmacological Sciences

Carolyn R. Bertozzi, Ph.D.
University of California-Berkeley
Regents of the University of California
Engineering novel cell surface chemistry for selective tumor cell targeting
Paid $65,000

Charles M. Brenner, Ph.D.
Thomas Jefferson University Jefferson Medical College
A genomic approach to identify chemotherapeutic targets
Approved $195,000 Paid $32,500

Kathleen Collins, Ph.D.
University of California-Berkeley
Regents of the University of California
Biochemical and structural characterization of recombinant Tetrahymena *telomerase*
Approved $195,000 Paid $32,500

Craig M. Crews, Ph.D.
Yale University School of Medicine
Exploring the pharmaceutical potential of PKC isozyme regulation using combinatorial chemistry
Paid $65,000

Cynthia Czajkowski, Ph.D.
University of Wisconsin-Madison Medical School
Board of Regents-University of Wisconsin
Molecular determination of the benzodiazepine and GABA binding sites of the $GABA_A$ *receptor*
Paid $65,000

Raymond J. Deshaies, Ph.D.
California Institute of Technology
Ubiquitin-dependent proteolysis
Paid $65,000

Haian Fu, Ph.D.
Emory University School of Medicine
Role of 14-3-3 proteins in signal transduction and oncogenesis
Paid $65,000

Bruce A. Hay, Ph.D.
California Institute of Technology
Identification and characterization of regulators of caspase-dependent cell death signaling
Approved $195,000 Paid $32,500

Linda A. Hicke, Ph.D.
Northwestern University
Ubiquitin-dependent internalization and degradation of signal transducing receptors
Paid $65,000

Kevin R. Jones, Ph.D.
University of Colorado-Boulder
Function of brain-derived neurotrophic factor in the basal ganglia
Paid $65,000

Kerry Kornfeld, M.D., Ph.D.
Washington University School of Medicine
Sar-5, a novel negative regulator of Ras signaling
Approved $195,000 Paid $32,500

Wendell Lim, Ph.D.
University of California-San Francisco School of Medicine
Regents of the University of California
Protein recognition in signal transduction: the structural and energetic basis of complex SH3 domain mediated interactions
Paid $65,000

Stephen Michnick, Ph.D.
University of Montreal Faculty of Medicine
Protein-fragment complementation assays: a general strategy for identifying relationships among proteins in vivo
Paid $65,000

Garry P. Nolan, Ph.D.
Stanford University School of Medicine
Dominant negative effectors of differentiation and intracellular signaling
Paid $65,000

Rama Ranganathan, M.D., Ph.D.
University of Texas Southwestern Medical Center-Dallas
Assembly and function of multi-protein complexes in visual signaling
Approved $195,000 Paid $40,000

Ronald Taussig, Ph.D.
University of Michigan Medical School
Regents of the University of Michigan
Genetic analysis of mammalian adenylyl cyclase isoforms
Paid $65,000

Wilfred A. van der Donk, Ph.D.
University of Illinois-Urbana-Champaign
Board of Trustees of the University of Illinois
Exploring the post-translational modifications of lantibiotics
Approved $195,000 Paid $32,500

Toxicological Sciences

Qin M. Chen, Ph.D.
University of Arizona College of Medicine
Tumor suppressor mediated oxidative stress responses
Paid $65,000

Philip A. Cole, M.D., Ph.D.
Rockefeller University
Chemical cross-linking agents for identification of substrates for protein kinases
Approved $195,000 Paid $32,500

Hilary A. Godwin, Ph.D.
Northwestern University
Biophysical approaches to lead toxicology: biochemistry, detection, and chelation of Pb(II)
Approved $195,000 Paid $32,500

Jeffrey A. Johnson, Ph.D.
University of Kansas Medical Center
Brain glutathione s-transferases and NADPH:quinone oxidoreductase: a role in preventing neurotoxicity
Paid $65,000

Yoichi Osawa, Ph.D.
University of Michigan Medical School
Regents of the University of Michigan
Chemical approaches to toxicology
Paid $65,000

Jennifer A. Pietenpol, Ph.D.
Vanderbilt University School of Medicine
Mechanism of cell cycle checkpoints following genotoxic stress
Paid $65,000

Zhigang Wang, Ph.D.
University of Kentucky
University of Kentucky Research Foundation
Mechanism of DNA damage-induced mutagenesis in humans
Approved $195,000 Paid $32,500

E. Lynn Zechiedrich, Ph.D.
Baylor College of Medicine
DNA repair and topoisomerases
Approved $195,000 Paid $32,500

SUBTOTAL
Approved $1,950,000 Paid $1,307,500

Scholar Awards in Experimental Therapeutics

Effective with the 1998 award year, this program was superseded by the Clinical Scientist Awards in Translational Research.

Arturo Casadevall, M.D., Ph.D.
Albert Einstein College of Medicine
Development of novel antibody-based drugs against bacterial and fungal pathogens
Paid $80,000

Elazer R. Edelman, M.D., Ph.D.
Harvard Medical School
Continuous perivascular drug delivery
Paid $80,000

Jonathan D. Gitlin, M.D.
Washington University School of Medicine
Mechanisms of cellular copper homeostasis
Paid $80,000

Daniel L. Kaufman, Ph.D.
University of California-Los Angeles School of Medicine
Regents of the University of California
Biopharmaceuticals for the prevention of insulin-dependent diabetes mellitus
Paid $80,000

Alan M. Krensky, M.D.
Stanford University School of Medicine
HLA-derived peptides as novel immunosuppressives
Paid $80,000

Thomas Michel, M.D., Ph.D.
Harvard Medical School
Brigham and Women's Hospital
Nitric oxide synthases and vascular signal transduction
Paid $80,000

Drew M. Pardoll, M.D., Ph.D.
Johns Hopkins University School of Medicine
Molecular engineering of the antitumor immune response
Paid $80,000

David H. Perlmutter, M.D.
Washington University School of Medicine
Receptor for amyloid-beta peptide
Paid $60,000

Stephen Rayport, M.D., Ph.D.
Columbia University College of Physicians and Surgeons
Trustees of Columbia University
Actions of psychotropic drugs at central nervous system synapses
Paid $60,000

Theresa A. Shapiro, M.D., Ph.D.
Johns Hopkins University School of Medicine
Development of new antiparasitic chemotherapy
Paid $80,000

Steven E. Shoelson, M.D., Ph.D.
Harvard Medical School
Joslin Diabetes Center Inc.
Targeting SH2 domains in tyrosine kinase signaling
Paid $80,000

SUBTOTAL
Paid $840,000

Scholar Awards in Toxicology

Effective with the 1998 award year, this program was superseded by the New Investigator Awards in the Pharmacological or Toxicological Sciences.

Kim Boekelheide, M.D., Ph.D.
Brown University School of Medicine
The role of cytoskeletal perturbation in testicular injury
Paid $80,000

Christopher Bradfield, Ph.D.
University of Wisconsin-Madison
Board of Regents-University of Wisconsin
Molecular genetic approaches to study dioxin toxicology
Paid $80,000

Janice E. Chambers, Ph.D.
Mississippi State University College of Veterinary Medicine
To understand factors contributing to toxicity so that predictions of which compounds pose the greatest hazard to man and/or animals can be developed
Paid $45,000

Titia de Lange, Ph.D.
Rockefeller University
Cell-based assays for telomerase toxicity
Paid $80,000

Debra L. Laskin, Ph.D.
Rutgers, the State University of New Jersey College of Pharmacy
To analyze the role of nitric oxide in cytokine-induced apoptosis in the liver
Paid $60,000

Ellen Li, M.D., Ph.D.
Washington University School of Medicine
Retinoic acid binding proteins and retinoid toxicity
Paid $80,000

Curtis J. Omiecinski, Ph.D.
University of Washington School of Public Health and Community Medicine
Molecular biological approaches to toxicology
Paid $80,000

Leona Samson, Ph.D.
Harvard School of Public Health
President and Fellows of Harvard College
Study of the body's natural defenses against alkylating agents
Paid $60,000

Dennis J. Thiele, Ph.D.
University of Michigan Medical School
Regents of the University of Michigan
Molecular mechanisms of metal detoxification
Paid $80,000

Bennett Van Houten, Ph.D.
University of Texas Medical Branch-Galveston
Gene-specific repair studies in mice and humans
Paid $80,000

SUBTOTAL
Paid $725,000

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Other Grants

In addition to its competitive awards, BWF makes noncompetitive grants for activities that are closely related to its major focus areas. These grants are intended to enhance the general environment for research in the targeted areas.

AMC Cancer Research Center
Support for Gene Environment Interactions: Emerging Issues, Technologies, and Biological Paradigms conference
Approved $1,000

American Association of Pharmaceutical Scientists
Support for 1998 New Investigator Grant in Pharmacokinetics, Pharmacodynamics, and Drug Metabolism
Approved $11,055 Paid $11,055

American Federation for Medical Research
Support for Biomedicine '98: Medical Research from Bench to Bedside
Approved $15,000 Paid $15,000

American Foundation for Pharmaceutical Education
Support for New Investigators Program for Pharmacy Faculty
Approved $718,000

American Foundation for Pharmaceutical Education
Support for 1997 and 1998 New Investigators Program for Pharmacy Faculty
Paid $193,000

American Society for Pharmacology
and Experimental Therapeutics
Support for Burroughs Wellcome Fund Lecture at society's 1998 annual meeting
Approved $4,200 Paid $4,200

American Society for Pharmacology
and Experimental Therapeutics
Support for symposium and Burroughs Wellcome Fund Lecture at society's 1999 annual meeting
Approved $8,700

Association of American Medical Colleges
Support for National Clinical Research Summit
Approved $50,000 Paid $50,000

Columbia University College of Physicians and Surgeons
Trustees of Columbia University
Support for bridging grant for Dr. Stephen Rayport, BWF Scholar in Experimental Therapeutics
Approved $42,262 Paid $42,262

Georgetown University
Support for planning Inheritance of Acquired Characteristics symposium, held in conjunction with the International Congress of Genetics
Approved $5,000

New York Academy of Medicine
Support for Basic Science Symposia on intercellular signaling in early development
Approved $5,000 Paid $5,000

State University of New York-Stony Brook
Support for two symposia commemorating 25th anniversary of the university's department of pharmacological sciences
Approved $1,500 Paid $1,500

University of Michigan Medical School
Regents of the University of Michigan
Support for International Symposium on Metals and Genetics
Approved $15,000 Paid $15,000

Gordon Research Conferences
Support for Burroughs Wellcome Fund symposium at 1998 Conference on Mechanisms of Toxicity, and for young scientists to attend the conference
Approved $5,000 Paid $5,000

University of Western Ontario
Support for International Conference on Metal-Binding Proteins in Biology: Their Roles in Gene Expression, Cell Injury, and Death
Approved $15,000 Paid $15,000

SUBTOTAL
Approved $896,717 Paid $357,017

TOTAL THERAPEUTIC SCIENCES

Approved $10,346,717 Paid $3,979,517

REPRODUCTIVE SCIENCE

Career Awards in the Biomedical Sciences

These awards targeted at reproductive sciences are made through the Career Awards in the Biomedical Sciences program; the majority of the career awards are listed under the "Career Development of Scientists" section of the Grants Index.

David E. Cummings, M.D.
University of Washington School of Medicine
Studies of spermatogenesis and metabolism using mutant mice
Paid $56,650

William L. Kraus, Ph.D.
University of California-San Diego
Regents of the University of California
Biochemical analysis of estrogen receptor activity with chromatin templates
Approved $412,500 Paid $27,500

Mala S. Mahendroo, Ph.D.
University of Texas Southwestern Medical Center-Dallas
Characterization of fecundity and parturition defects in mice deficient in steroid 5 alpha-reductase type 1
Paid $56,650

Kelle H. Moley, M.D.
Washington University School of Medicine
Glucose transport and apoptosis in blastocysts from diabetic mice
Approved $412,500 Paid $27,500

Carmen J. Williams, M.D., Ph.D.
University of Pennsylvania School of Medicine
Trustees of the University of Pennsylvania
Signal transduction mechanisms during mouse egg activation
Paid $56,650

SUBTOTAL
Approved $825,000 Paid $224,950

Obstetrics and Gynecology Research Fellowships

These awards are administered in partnership with the American Association of Obstetricians and Gynecologists Foundation. BWF awards the primary grant to the foundation, which distributes the funds to the individual awardees.

Donna S. Dizon-Townson, M.D. (1996-98)
University of Utah
Isolation of trophoblast and decidual genes unique to different gestational ages of early human pregnancy without prior knowledge of gene function or structure
Paid $20,000

Henry L. Galan, M.D. (1997-2000)
University of Colorado Health Sciences Center
Role of endothelial nitric oxide in the fetal placental unit in an experimental model of intrauterine growth restriction
Paid $48,000

Douglas A. Woelkers, M.D. (1998-2001)
University of Pittsburgh School of Medicine
Oxidative stress and preeclampsia
Approved $144,000 Paid $24,000

SUBTOTAL
Approved $144,000 Paid $92,000

Reproductive Scientist Development Program Research Grants

These awards are administered in partnership with the Reproductive Scientist Development Program. BWF awards the primary grant to the program, which distributes the funds to the individual awardees.

Carolyn Y. Muller, M.D.
University of Texas Southwestern Medical Center-Dallas
Prospective determination of genetic alterations in cervical preneoplasia with correlation risk exposure and behavior
Approved $240,000 Paid $80,000

SUBTOTAL
Approved $240,000 Paid $80,000

Other Grants

In addition to its competitive awards, BWF makes noncompetitive grants for activities that are closely related to its major focus areas. These grants are intended to enhance the general environment for research in the targeted areas.

American Association of Obstetricians and Gynecologists Foundation
Support for administration of Obstetrics and Gynecology Research Fellowships
Approved $10,000 Paid $10,000

Marine Biological Laboratory
Support for Frontiers in Reproduction training course
Paid $150,000

Northwestern University Medical School
Support for Frontiers in Reproduction symposium
Approved $10,000 Paid $10,000

Society for the Study of Reproduction
Support for postdoctoral fellows to attend society's annual meeting
Approved $10,000 Paid $10,000

SUBTOTAL
Approved $30,000 Paid $180,000

TOTAL REPRODUCTIVE SCIENCE

Approved $1,239,000 Paid $576,950

INTERFACES BETWEEN THE PHYSICAL/CHEMICAL/ COMPUTATIONAL SCIENCES AND THE BIOLOGICAL SCIENCES

Interfaces Programs

Interdisciplinary Graduate and Postdoctoral Training Program in Physics, Chemistry, and Biology
Rockefeller University
Stephen K. Burley, M.D., D.Phil.
Albert Libchaber, Ph.D.
Paid $489,000

La Jolla Interfaces in Science Training Program
(Consortium of the University of California-San Diego, the Scripps Research Institute, the Salk Institute for Biological Research, and the San Diego Supercomputing Center)
Regents of the University of California
Elizabeth D. Getzoff, Ph.D.
Scripps Research Institute
José N. Onuchic, Ph.D.
University of California-San Diego
Paid $459,375

Program in Computational Molecular Biology
California Institute of Technology
Scott E. Fraser, Ph.D.
Michael L. Roukes, Ph.D.
Paid $500,000

Program in Mathematics and Molecular Biology
(Multi-university, interdisciplinary national research and training consortium composed of 17 laboratories representing 12 institutions)
Florida State University Research Foundation Inc.
DeWitt L. Sumners, Ph.D.
Florida State University
Sylvia J. Spengler, Ph.D.
University of California-Berkeley
Paid $500,000

SUBTOTAL
Paid $1,948,375

Other Grants

In addition to its competitive awards, BWF makes noncompetitive grants for activities that are closely related to its major focus areas. These grants are intended to enhance the general environment for research in the targeted areas.

Florida State University
Florida State University Research Foundation Inc.
Support for 1998 Burroughs Wellcome Fund Doing Science at the Interface workshop
Approved $26,000 Paid $26,000

Marine Biological Laboratory
Support for Modeling of Biological Systems: an Interdisciplinary Course
Approved $350,000 Paid $175,000

Marine Biological Laboratory
Support for planning Modeling of Biological Systems: an Interdisciplinary Course
Approved $40,000 Paid $40,000

Rutgers, the State University of New Jersey-Piscataway
Rutgers University/Center for Advanced Biotechnology and Medicine
Support for Structure-Based Functional Genomics: from Gene Sequence to Function workshop
Approved $10,000 Paid $10,000

University of Texas-Austin College of Pharmacy
Support for Eighth Southwestern Graduate Medicinal Chemistry Conference
Approved $500 Paid $500

SUBTOTAL
Approved $426,500 Paid $251,500

TOTAL INTERFACES BETWEEN THE PHYSICAL/CHEMICAL/COMPUTATIONAL SCIENCES AND THE BIOLOGICAL SCIENCES

Approved $426,500 Paid $2,199,875

SCIENCE EDUCATION

Student Science Enrichment Program

American Chemical Society, North Carolina Local Section
Summer Educational Experience for the Disadvantaged (SEED)
Approved $169,700 Paid $51,080

American Heart Association, North Carolina Council
High School Student Research Program
Approved $18,500 Paid $38,500

Appalachian State University
Science and Technology Skill Building for Female Students and Their Female Teachers
Approved $12,140 Paid $44,048

Brevard College
Voice of the Rivers, Phase II: Sharing through Education
Approved $59,874 Paid $59,874

Campbell University School of Pharmacy
Harnett Central Middle School Science and Technology Enrichment Program (STEP)
Approved $120,405 Paid $39,550

Catawba Science Center Inc.
Circle of Support
Approved $10,000 Paid $53,930

Chowan College
Northeastern North Carolina Science Camp
Approved $6,710 Paid $41,710

Cumberland County Schools
Cape Fear High School Science Academy
Approved $17,246 Paid $45,454

Duke University
Talent Identification Program (TIP)
Approved $18,500 Paid $78,500

Durham Academy
Durham Public Schools Summer Institute
Approved $15,097 Paid $45,097

Durham Public Schools
Bridging Education Science and Technology (BEST) High School Molecular Research Preparation Course
Approved $155,055 Paid $52,785

Grey Culbreth Middle School
Seeking Environmental Awareness Researching Chapel Hill (SEARCH)
Approved $7,000 Paid $27,000

North Carolina Aquarium on Roanoke Island
North Carolina Aquarium Society
A Mentor-Learner Approach to Science Enrichment
Approved $16,134 Paid $76,134

North Carolina Museum of Life and Science
Building the Science Ladder
Approved $18,450 Paid $80,039

North Carolina State Museum of Natural Sciences
Girls in Science
Approved $10,650 Paid $30,220

North Carolina State University
Science and Mathematics Colloquies at the Science House
Approved $5,500 Paid $65,500

Pines of Carolina Girl Scout Council
Science and Technology around Research Triangle Park (START-UP)
Approved $7,500 Paid $65,900

Science Museums of Wilson: Imagination Station
Minorities' Interest Nurtured and Developed in Science (MINDS) Student Scientist Program
Approved $113,696 Paid $28,156

Science STARS Universe
A Universe of Possibilities
Approved $18,500 Paid $69,500

SciWorks
Science in the City
Paid $60,749

Shodor Education Foundation Inc.
Stimulating Understanding of Computational Science through Collaboration, Exploration, Experiment, and Discovery (SUCCEED)
Approved $17,572 Paid $74,672

Southeastern Community College
Explorations in Science
Approved $89,946   Paid $31,982

University of North Carolina-Chapel Hill
Adventures in Biomolecular Sciences
Approved $18,500   Paid $68,540

University of North Carolina-Chapel Hill School of Medicine
Research Apprenticeship Program (RAP)
Approved $179,673   Paid $59,891

University of North Carolina Mathematics
and Science Education Network
Pre-College Exploring Science Program
Approved $18,470   Paid $78,470

University of North Carolina-Wilmington
Cape Fear Science Camp
Approved $15,100   Paid $52,642

University of North Carolina-Wilmington
Oceanographic Field Support for Summer Ventures in Science and Mathematics
Approved $12,458   Paid $21,908

Wake Forest University School of Medicine
Linking Career Choices to Student Experiences: Mini-Fellowships in Science Fields
Approved $178,380   Paid $59,460

SUBTOTAL
Approved $1,330,756   Paid $1,501,291

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Wellcome Visiting Professorships in the Basic Medical Sciences

Listed by host institution, visiting professor, and professor's affiliation. Titles of Wellcome Lectures cited if given in fiscal year 1998.

Note: Beginning with the 1999-2000 award series, the program name is changed to BWF Visiting Professorships in the Basic Medical Sciences.

Allegheny University of the Health Sciences
E. Richard Moxon, M.D., B.Chir.
University of Oxford
Approved $5,000

Central Caribbean University School of Medicine
Universidad Central Del Caribe School of Medicine
George P. Hess, Ph.D.
Cornell University
Approved $5,000

Duke University Medical Center
Jerry W. Shay, Ph.D.
University of Texas Southwestern Medical Center-Dallas
Approved $5,000

East Carolina University
Medical Foundation of East Carolina University
Alan C. Sartorelli, Ph.D.
Yale University School of Medicine
Hypoxic cells of solid tumors: a site of vulnerability
Paid $5,000

Emory University School of Medicine
Jeffrey I. Gordon, M.D.
Washington University School of Medicine
Approved $5,000

Greenwood Genetic Center
Kathleen K. Sulik, Ph.D.
University of North Carolina-Chapel Hill
The magic and mystery of human development
Paid $5,000

Iowa State University
Simin Meydani, D.V.M., Ph.D.
Tufts University
Approved $5,000

Johns Hopkins University
Eli E. Sercarz, Ph.D.
University of California-Los Angeles
Antigen-centered and TCR-centered regulation of autoimmunity
Paid $5,000

Kansas State University
Claude E. Klee, M.D.
National Cancer Institute
National Institutes of Health
Approved $5,000

Louisiana State University School of Medicine-New Orleans
Louis J. Ignarro, Ph.D.
University of California-Los Angeles School of Medicine
Approved $5,000

Medical College of Wisconsin
Robert Unwin, Ph.D.
University College London Medical School
Approved $5,000

Medical University of South Carolina
Alexander Rich, M.D.
Massachusetts Institute of Technology
DNA as a dynamic system: the left-handed DNA form
Paid $5,000

Meharry Medical College
Bertil Hille, Ph.D.
University of Washington School of Medicine
G-protein-coupled receptors rule the mind
Paid $5,000

Meharry Medical College
Oliver Smithies, D.Phil.
University of North Carolina-Chapel Hill School of Medicine
Approved $5,000

Memorial University of Newfoundland Faculty of Medicine
Mary-Claire King, Ph.D.
University of Washington
Approved $5,000

Morehouse School of Medicine
Stephen B. Liggett, M.D.
University of Cincinnati
Molecular genetics of beta-adrenergic receptors: from cloning to heart and lung disease
Paid $5,000

New York Medical College
David G. Harrison, M.D.
Emory University School of Medicine
New concepts regarding regulation of redox state
Paid $5,000

New York Medical College
Stanley G. Nathenson, M.D.
Albert Einstein College of Medicine
An odyssey: searching for the structural basis of major histocompatibility complex function
Paid $5,000

North Dakota State University
William H. Dietz, M.D., Ph.D.
Centers for Disease Control and Prevention
Approved $5,000

Northeast Louisiana University College of Pharmacy and Health Sciences
Sidney D. Nelson, Ph.D.
University of Washington School of Pharmacy
Metabolism and toxicity of a monoterpene constituent of an herbal product used as an abortive agent
Paid $5,000

Northeastern Ohio Universities College of Medicine
Donald M. McDonald, M.D., Ph.D.
University of California-San Francisco School of Medicine
Approved $5,000

Pennsylvania State University
Chung S. Yang, Ph.D.
Rutgers, the State University of New Jersey
Approved $5,000

Rutgers, the State University of New Jersey-Newark
Fred H. Gage, Ph.D.
Salk Institute for Biological Sciences
Neurogenesis and regeneration in the brain
Paid $5,000

Rutgers, the State University of New Jersey-Piscataway
Zippora Shakked, Ph.D.
Weizmann Institute for Science
DNA structure and gene regulation
Paid $5,000

San Juan Bautista School of Medicine
Emil Skamene, M.D.
McGill University
Approved $5,000

Thomas Jefferson University Jefferson Medical College
Jennifer Lippincott-Schwartz, Ph.D.
National Institute of Child Health and Human Development
National Institutes of Health
Approved $5,000

Tulane University School of Medicine
Pierre Corvol, M.D.
College of France
Approved $5,000

University of Alberta
Sir James W. Black, M.B., Ch.B.
King's College School of Medicine and Dentistry
Approved $5,000

University of Arizona College of Medicine
W. James Nelson, Ph.D.
Stanford University Medical Center
Approved $5,000

University of California-Berkeley
Regents of the University of California
Luigi M. De Luca, Ph.D.
National Cancer Institute
National Institutes of Health
Approved $5,000

University of California-San Francisco
Regents of the University of California
Alan R. Fersht, Ph.D.
University of Cambridge
Protein folding in vitro
Paid $5,000

University of Colorado-Boulder
Paul Nurse, Ph.D.
Imperial Cancer Research Fund
Approved $5,000

University of Georgia
University of Georgia Research Foundation
John W. Erdman Jr., Ph.D.
University of Illinois-Urbana-Champaign
Dietary reference intakes: revising the RDAs
Paid $5,000

University of Guelph
Karlheinz Altendorf, Ph.D.
University of Osnabruck
Approved $5,000

University of Manitoba Faculty of Medicine
Stephen E. Epstein, M.D.
Washington Hospital Center
Approved $5,000

University of Maryland
David W. Rice, D.Phil.
University of Sheffield
From life in a pressure cooker to gene recombination: a structural biologist's view of evolution
Paid $5,000

University of Massachusetts Medical School
Ronald M. Evans, Ph.D.
Salk Institute for Biological Studies
Nuclear receptors: a superfamily
Paid $5,000

University of Medicine and Dentistry of New Jersey
Peter B. Dervan, Ph.D.
California Institute of Technology
Regulation of gene expression by small molecules
Paid $5,000

University of Missouri-Columbia
Curators of the University of Missouri
Christine E. Seidman, M.D.
Genes that pattern the heart
Jonathan G. Seidman, Ph.D.
Hypertrophic cardiomyopathy from man to mouse
Harvard Medical School
Paid $5,000

University of North Carolina-Chapel Hill
Susan Seroto Taylor, Ph.D.
University of California-San Diego
cAMP-dependent protein kinase: structural prototype for the protein kinase superfamily and regulation and localization
Paid $5,000

University of North Carolina-Greensboro
Cheryl Achterberg, Ph.D.
Pennsylvania State University
Approved $5,000

University of North Dakota School of Medicine and Health Sciences
John R. Hassell, Ph.D.
University of Pittsburgh
Paid $5,000

University of Northern Iowa
Thomas A. Pressley, Ph.D.
Texas Tech University Health Sciences Center
Approved $5,000

University of Oklahoma Health Sciences Center
Board of Regents of the University of Oklahoma
James Hill, Ph.D.
Louisiana State University Eye Center
Approved $5,000

University of Pittsburgh School of Medicine
Alfred Singer, M.D.
National Cancer Institute
National Institutes of Health
Approved $5,000

University of Rochester Medical School
University of Rochester Cancer Center
Thomas J. Schall, Ph.D.
DNAX Research Institute
Novel dendritic cell chemokine receptor: application to cancer chemotherapy
Paid $5,000

University of South Dakota School of Medicine
Eric N. Olson, Ph.D.
University of Texas Southwestern Medical Center-Dallas
Genetic control of muscle development
Paid $5,000

University of Tennessee-Memphis College of Medicine
David E. Clapham, M.D., Ph.D.
Harvard Medical School
Approved $5,000

University of Texas Health Science Center-Houston
Tom Curran, Ph.D.
St. Jude Children's Research Hospital
Molecular basis of brain development: lessons from mutant mice
Paid $5,000

University of Texas Medical Branch-Galveston
Agnes B. Kane, M.D., Ph.D.
Brown University
Mechanisms of asbestos carcinogenesis
Paid $5,000

University of Utah
Cecil B. Pickett, Ph.D.
Schering-Plough Research Institute
Regulation of gene expression by oxidative stress
Paid $5,000

University of Vermont College of Medicine
Johan P. Stenflo, M.D., Ph.D.
Lund University
Approved $5,000

University of Washington School of Medicine
Solomon H. Snyder, M.D.
Johns Hopkins University School of Medicine
Approved $5,000

University of Wyoming
Jack L. Strominger, M.D.
Harvard University
Natural killer cells: their ligands, receptors, and functions
Paid $5,000

Washington State University
Ian F. C. McKenzie, M.D., Ph.D.
Austin Research Institute
Overcoming problems in pig to human transplants
Paid $5,000

Washington State University College of Pharmacy
Ronald T. Borchardt, Ph.D.
University of Kansas
Pharmaceutical sciences in the 21st century: important scientific and educational issues
Paid $5,000

Wayne State University School of Medicine
Piet Borst, M.D., Ph.D.
Netherlands Cancer Institute
Multidrug resistance in cancer: lessons from knockout mice and biochemical experiments
Paid $5,000

West Virginia University School of Medicine
West Virginia University Research Corporation
George J. Augustine, Ph.D.
Duke University Medical Center
Approved $5,000

Wright State University School of Medicine
Peter Arvan, M.D., Ph.D.
Albert Einstein College of Medicine
Approved $5,000

Yale University School of Medicine
Stephen J. Benkovic, Ph.D.
Pennsylvania State University
Approved $5,000

York University
Michael W. Gray, Ph.D.
Dalhousie University Faculty of Medicine
Approved $5,000

SUBTOTAL
Approved $165,000 Paid $140,000

Wellcome Visiting Professorships in the Microbiological Sciences

Listed by host institution, visiting professor, and professor's affiliation. Titles of Wellcome Lectures cited if given in fiscal year 1998.

Note: Beginning with the 1999-2000 award series, the program name is changed to BWF Visiting Professorships in the Microbiological Sciences.

Florida International University
Valerie J. Smith, Ph.D.
University of Saint Andrews
Closing the circle: immunity, invertebrates, and holism
Paid $5,000

Georgia Southern University
Georgia Southern University Foundation Inc.
Masahito Fukunaga, Ph.D.
Fukuyama University Faculty of Pharmacy
Molecular taxonomy and global distribution of borrelial spirochetes and their adaptation to vector ticks
Paid $5,000

Lehigh University
Susan R. Ross, Ph.D.
University of Pennsylvania School of Medicine
Approved $5,000

Louisiana State University
Tlahun D. Yilma, D.V.M., Ph.D.
University of California-Davis School of Veterinary Medicine
Approved $5,000

Meharry Medical College
Francis L. Macrina, Ph.D.
Virginia Commonwealth University School of Medicine
Approved $5,000

Oakland University
Thomas J. Silhavy, Ph.D.
Princeton University
Approved $5,000

Pittsburg State University
Ralph Tanner, Ph.D.
University of Oklahoma
Bacterial diversity: a gold mine for technology
Paid $5,000

Saint Cloud State University
Saint Cloud State University Foundation
Jill E. Clarridge, Ph.D.
Veterans Affairs Medical Center-Houston
Bacteria don't read the books: real-life clinical microbiology
Paid $5,000

Southern University-Baton Rouge
Southern University & A&M College
Paul S. Miller, Ph.D.
Johns Hopkins University School of Hygiene and Public Health
Design and synthesis of oligonucleotides and their applications to problems in molecular biology
Paid $5,000

University of Alberta Faculty of Medicine and Oral Health Sciences
Barry J. Marshall, M.D.
University of Virginia Health Sciences Center
Approved $5,000

University of Dayton
Barbara H. Iglewski, Ph.D.
University of Rochester School of Medicine and Dentistry
Approved $5,000

University of Florida
University of Florida-IFAS
Kenneth E. Rudd, Ph.D.
University of Miami School of Medicine
Approved $5,000

University of Puerto Rico School of Medicine
Jay A. Levy, M.D.
University of California-San Francisco School of Medicine
Approved $5,000

University of Texas Health Science Center-San Antonio
John J. Mekalanos, Ph.D.
Harvard Medical School
Approved $5,000

Virginia Union University
Clifford Houston, Ph.D.
University of Texas Medical Branch-Galveston
Approved $5,000

SUBTOTAL
Approved $50,000 Paid $25,000

Other Grants

In addition to its competitive awards, BWF makes noncompetitive grants for activities that are closely related to its major focus areas. These grants are intended to enhance the general environment for research in the targeted areas.

Alzheimer's Association
Support in lieu of honoraria for Dr. Elmima Johnson, member of BWF Student Science Enrichment Program Advisory Committee
Approved $1,250   Paid $1,250

American Heart Association
Support in lieu of honoraria for Dr. Elmima Johnson, member of BWF Student Science Enrichment Program Advisory Committee
Approved $1,250   Paid $1,250

American Society for Microbiology
Support for administration of 1997 Wellcome Visiting Professorships in the Microbiological Sciences
Approved $500   Paid $500

American Society for Microbiology
Support for administration of 1998 Wellcome Visiting Professorships in the Microbiological Sciences
Approved $2,500   Paid $2,500

Canadian Federation of Biological Societies
Support for administration of 1998 Wellcome Visiting Professorships in the Basic Medical Sciences
Approved $2,500   Paid $2,500

Federation of American Societies for Experimental Biology
Support for administration of 1997 Wellcome Visiting Professorships in the Basic Medical Sciences
Approved $8,377   Paid $8,377

Federation of American Societies for Experimental Biology
Support for administration of 1998 Wellcome Visiting Professorships in the Basic Medical Sciences
Approved $9,510   Paid $9,510

Grantmakers for Education
Tides Center/Grantmakers for Education
Support for general activities
Approved $500   Paid $500

Medical Research Council of Canada
Support for Burroughs Wellcome Fund Student Research Awards
Approved $1,000,000   Paid $500,000

National Academy Press
Support for distribution of National Science Standards to BWF Student Science Enrichment Program awardees
Approved $1,449   Paid $1,449

North Carolina Central University
Support for Regional Science Bowl for high school students
Approved $3,500   Paid $3,500

North Carolina School of Science and Mathematics
Support for Education Future Center
Paid $70,336

North Carolina Science Olympiad
Support for 1999 tournament
Approved $5,000   Paid $5,000

Public School Forum of North Carolina
Support for Institute for Educational Policymakers
Paid $150,000

Shodor Education Foundation Inc.
Support for development of BWF Student Science Enrichment Program Electronic Network
Approved $45,000   Paid $45,000

University of North Carolina-Chapel Hill
Support for expansion and revitalization of M.D.-Ph.D. program
Approved $50,000   Paid $50,000

SUBTOTAL
Approved $1,131,336   Paid $851,672

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TOTAL SCIENCE EDUCATION

Approved $2,677,092   Paid $2,517,963

ENVIRONMENT FOR SCIENCE

Additional grants made through this program are listed in the previous sections under "Other Grants."

General

American Association for the Advancement of Science
Support for Center for Science, Technology, and Congress
Paid $75,000

American Association for the Advancement of Science
Support for How to Fund Science: the Future of Medical Research workshop
Approved $87,350

American Enterprise Institute for Policy Research
Support for study of biomedical research policy
Approved $25,000   Paid $25,000

American Heart Association, North Carolina Council
Support for general activities
Approved $3,000   Paid $3,000

Association of Military Surgeons of the United States
Support for Sir Henry Wellcome Medal and Prize
Paid $2,500

Canadian Society for Clinical Investigation
Royal College of Physicians and Surgeons of Canada
Support for Henry Friesen Award and Lectureship
Approved $20,000   Paid $20,000

Council on Foundations
Support for general activities
Approved $34,600   Paid $34,600

Duke University School of Medicine
Duke Children's Hospital
Support for general activities
Approved $5,500   Paid $5,500

Fight for Sight Inc.
Support for Mildred Weisenfeld Memorial Fund
Approved $1,000   Paid $1,000

Foundation Center
Support for general activities
Approved $5,000   Paid $5,000

Friends of the National Library of Medicine
Support for general activities
Approved $5,000   Paid $5,000

Fund for Johns Hopkins Medicine
Support in memory of Dr. A. M. Harvey, former chair of BWF Clinical Pharmacology Advisory Committee
Approved $1,000   Paid $1,000

Harvard School of Public Health
President and Fellows of Harvard College
Support for Jere Mead Fund
Approved $10,000   Paid $10,000

Medical Research Council of Canada
Support for the planning of a 21st century health sciences research institute system
Approved $150,000

North Carolina Center for Nonprofits
Support for center's annual conference
Approved $3,000   Paid $3,000

North Carolina Center for Nonprofits
Support for general activities
Approved $500   Paid $500

Research!America
Support for second phase of 435 Project
Approved $25,000   Paid $25,000

Sigma Xi
Support for society's International Cooperation in Science and Technology Development forum
Approved $20,000   Paid $20,000

Society for the Advancement of Women's Health Research
Support for general activities
Approved $5,000   Paid $5,000

Southeastern Council of Foundations
Support for general activities
Approved $4,000   Paid $4,000

Southeastern Council of Foundations
Support for Robert H. Hull Leadership Development Fund
Approved $10,000   Paid $10,000

Triangle Community Foundation
Support for general activities
Approved $5,000   Paid $5,000

Triangle Community Foundation
Support for George H. Hitchings Fund for Health Research and Science Education, named in honor of former BWF president and board member
Approved $500,000 Paid $500,000

University of North Carolina-Chapel Hill
UNC-CH Health Sciences Library
Support in memory of Dr. Carl W. Gottschalk, former BWF advisory committee member
Approved $2,500 Paid $2,500

University of North Carolina-Chapel Hill School of Medicine
Lineberger Comprehensive Cancer Center
Support for conference and board room named in honor of Dr. Joseph Pagano, BWF board member
Approved $3,000 Paid $3,000

University of North Carolina-Chapel Hill School of Medicine
Support for conference and board room named in honor of Dr. Joseph Pagano, BWF board member
Approved $20,000

SUBTOTAL
Approved $945,450 Paid $765,600

Communications

American Association for the Advancement of Science
Support for Mass Media Science and Engineering Fellows Program
Approved $15,000 Paid $15,000

American Association for the Advancement of Science
Support for EurekAlert!
Approved $120,000 Paid $60,000

Council for the Advancement of Science Writing
Support for New Horizons in Science Briefing and for travel fellowships to meeting
Approved $20,000 Paid $20,000

National Journal of Young Investigators
Duke University
Support for general activities
Approved $35,140 Paid $35,140

National Journal of Young Investigators
Duke University
Support for general activities
Approved $20,000 Paid $20,000

Sigma Xi
Support for Media Resource Service
Approved $25,000 Paid $25,000

SUBTOTAL
Approved $235,140 Paid $175,140

History of Medicine

American Association for the History of Medicine
Support for association's annual meeting
Approved $2,000 Paid $2,000

American Association for the History of Medicine Foundation
Support for Jack Pressman-Burroughs Wellcome Fund Career Development Award in 20th Century History of Medicine or Science
Approved $7,000 Paid $50,000

Institute of Medicine
National Academy of Sciences
Support for publishing and distributing a history of the Institute of Medicine
Approved $10,000 Paid $10,000

National Humanities Center
Support for Burroughs Wellcome Fund Fellowship in the History of Modern Medicine
Approved $240,000 Paid $80,000

Russell Maulitz, M.D., Ph.D.
Allegheny University of the Health Sciences
Support for converting the Surgeon General's Index-Catalogue (1880-1936) *to CD-ROM*
Approved $10,000 Paid $10,000

SUBTOTAL
Approved $269,000 Paid $152,000

Inactive Programs—Active Awardees of Former Programs

Epilepsy Fellowships

These awards are administered in partnership with the Epilepsy Foundation of America. BWF awards the primary grant to the foundation, which distributes the funds to the individual awardees.

Nicholas P. Poolos, M.D., Ph.D.
Baylor College of Medicine
Imaging epileptiform activity in hippocampal pyramidal cells in vitro
Paid $15,000

Hitchings-Elion Trust Fellowships

Arthur L. Kruckeberg, Ph.D.
University of California-Los Angeles
Regents of the University of California
Structure and function of yeast sugar transport proteins
Approved $2,372 Paid $2,372

James McDonnell, Ph.D.
Rockefeller University
Biophysical characterization of IgE network interaction
Paid $3,000

Peter E. Warburton, Ph.D.
Mount Sinai School of Medicine
Chromosomal replication control in transfected YACS
Paid $7,500

New Investigator Awards in Virology

These awards are administered in partnership with the Infectious Diseases Society of America. BWF awards the primary grant to the society, which distributes the funds to the individual awardees.

Betsy Herold, M.D.
University of Chicago
Herpes simplex viral infections
Paid $15,750

Jeffery L. Meier, M.D.
University of Iowa College of Medicine
Mechanisms governing human cytomegalovirus latency
Paid $31,500

Scholar Awards in Immunopharmacology

These awards are administered in partnership with the American Academy of Allergy and Immunology. BWF awards the primary grant to the academy, which distributes the funds to the individual awardees.

Jonathan P. Arm, M.D.
Harvard Medical School
Structure and function of GP49, a novel member of the immunoglobulin superfamily, expressed on mast cells and monocytes
Paid $70,000

Thomas P. Atkinson, M.D., Ph.D.
University of Alabama-Birmingham
Regulation of phospholipase C by the IgE receptor on mast cells
Paid $70,000

Bruce S. Bochner, M.D.
Johns Hopkins University School of Medicine
Johns Hopkins Asthma and Allergy Center
Mechanisms of eosinophil and basophil recruitment in human allergic diseases
Paid $52,500

SUBTOTAL
Approved $2,372 Paid $267,622

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TOTAL ENVIRONMENT FOR SCIENCE

Approved $1,451,962 Paid $1,360,362

Information for Applicants

The Burroughs Wellcome Fund makes approximately 90 percent of its grants through competitive award programs, which support investigators in targeted areas of basic scientific research that have relevance to human health. Most of the award programs are open to scientists who are citizens or permanent residents of the United States and Canada. A few programs are open only to U.S. scientists, as noted in the program descriptions that follow. Awards are made with the advice of BWF's advisory committees, which are composed of scientists and educators selected for their expertise in the program areas. Program application deadlines for the 2000 award series are listed in the "Program Application Deadlines" section.

Most awards are made only to degree-granting institutions on behalf of individual researchers, who must be nominated by their institution. All institutions receiving awards must be tax-exempt 501(c)(3) organizations. Government agencies, such as the National Institutes of Health and the Centers for Disease Control and Prevention, are not eligible for awards.

BWF does not support activities that are primarily clinical in nature (such as disease diagnosis and treatment) or primarily related to health care and health care policy. BWF generally does not provide support for research projects or other activities outside its competitive programs, nor does it generally support endowments, development campaigns, ordinary operating expenses, capital facilities and equipment, or publications.

To Obtain Information about Programs

Burroughs Wellcome Fund
4709 Creekstone Drive, Suite 100
Durham, NC 27703-8472
Telephone (919) 991-5100
Fax (919) 941-5884

Information about BWF and its award programs can be obtained electronically by sending an e-mail message to mailback@bwfund.org—type the word "menu" on the subject line for a list of programs. To request a specific program brochure to be delivered by regular mail, or to send a message to a BWF program officer, access the Fund at info@bwfund.org.

Program information is available on BWF's website at http://www.bwfund.org

Career Development of Scientists

Career Awards in the Biomedical Sciences

These awards are intended to foster the development of biomedical researchers who are early in their careers and help them make the critical transition to becoming independent investigators. The awards provide support ranging from $445,000 for four years to $574,000 for six years to bridge the advanced postdoctoral years and the first three years of faculty service. Recipients may spend part of the award period at an institution in the United Kingdom or the Republic of Ireland. It is anticipated that at least 20 awards will be made annually; at least one of the awards will be targeted at reproductive science. Approximately half of the awards will go to researchers with a Ph.D. degree and half to those with an M.D. or M.D.-Ph.D. degree. Candidates must have completed at least 12 months but not more than 48 months of postdoctoral research training by the application deadline. For candidates with M.D. degrees, postdoctoral training excludes clinically oriented residencies that do not contain a major research component. Researchers who hold a faculty appointment as an assistant professor or the equivalent, or who know they will hold such an appointment within a year of the application deadline, are not eligible.

Hitchings-Elion Fellowships

These awards are intended to help promising researchers in the biomedical sciences and medically oriented behavioral sciences make the critical transition to becoming independent investigators. The fellowships, which provide a total of $332,500 over five years, support two years of postdoctoral training in the United Kingdom or the Republic of Ireland, a transitional year either to complete training abroad or to return to North America for additional postdoctoral training, and two faculty years at a U.S. or Canadian university. Up to five fellowships will be awarded annually. Candidates must hold or expect to receive an M.D. or Ph.D. degree, and they generally must have not more than 24 months of postdoctoral experience by the application deadline. (Candidates with more postdoctoral experience may be considered, if they can demonstrate a clear need to participate in training in the United Kingdom or Ireland; such candidates should contact BWF before applying to determine whether they are eligible.) Candidates in the behavioral sciences must be working in areas that have biomedical relevance; behavioral scientists should contact BWF before applying to determine whether they are eligible. U.K. or Irish host institutions may include universities, medical or veterinary schools, scientific institutes, and government laboratories, but not industrial laboratories. Fellows are not required to return to the same institution they were affiliated with prior to the award.

Life Sciences Research Fellowships

These awards provide $123,000 over three years for U.S. postdoctoral scientists pursuing research careers in the life sciences. It is anticipated that three awards will be made annually. These fellowships are administered in partnership with the Life Sciences Research Foundation (LSRF); contact LSRF for information (410/467-2597).

BWF Research Travel Grants

(Including History of Medicine)

These grants—previously called Wellcome Research Travel Grants—enable biomedical scientists and medical historians to work for brief periods (from two weeks to six months) in the United Kingdom or the Republic of Ireland. Scientific investigators may participate in collaborative research projects in the basic biomedical sciences, medically oriented behavioral sciences, and clinical research, or they may participate in training projects to acquire new research techniques. Medical historians may participate in collaborative research projects or they may conduct their own projects. BWF annually makes approximately 70 grants, including 10 in the history of medicine. Grants, which cover travel and subsistence expenses, average $6,000 (range: $1,500 to $15,000). Grants are not intended to support travel to international meetings. Scientific investigators and medical historians must have an M.D. or Ph.D. degree and hold an academic appointment at the assistant professor level or above at a degree-granting institution. On a trial basis, BWF will accept a limited number of applications from postdoctoral fellows and advanced graduate students working in the basic biomedical sciences, medically oriented behavioral sciences, or clinical research. Postdoctoral fellows must be early in their careers, and graduate students must be within a year of receiving their doctorates.

Emerging Infectious Diseases

Scholar Awards and New Investigator Awards in Molecular Parasitology

These awards are intended to foster the development and productivity of scientists who will bring new ways of thinking and new experimental approaches to the study of parasitic diseases, which have been relatively neglected as targets for basic research. Scholar awards provide $425,000 over five years ($85,000 per year) and new investigator awards provide $210,000 over three years ($70,000 per year). It is anticipated that two scholar awards and four new investigator awards will be made annually. The awards are intended to give recipients the freedom and flexibility to pursue new avenues of inquiry and higher-risk research projects that hold potential for advancing significantly the biochemical, pharmacological, immunological, and molecular biological knowledge of major pathogens and arthropod vectors that spread parasitic diseases. BWF is interested particularly in supporting investigators who will move modern molecular techniques into the study of parasitic systems as well as investigators whose work will extend the study of parasites in new directions. Candidates must have an M.D. or Ph.D. degree. Candidates for scholar awards must have established a record of independent research and hold a tenure-track position as an associate professor or its equivalent. Consideration also will be given to more senior investigators who are either significantly reorienting their research from another field to molecular parasitology or significantly switching research directions within the field. Candidates for new investigator awards must hold a tenure-track position as an assistant professor or its equivalent, and they must have established a record of independent research at the faculty level.

New Initiatives in Malaria Research

These awards are intended to increase the fundamental understanding of the biology and pathogenesis of malaria. Two types of awards are offered. One type, which provides up to $400,000 over a period of four years (up to $100,000 per year), is intended to support studies that bring new ways of thinking and new experimental approaches to malaria research. The second type, which provides $100,000 over a period of two years ($50,000 per year), is intended to support feasibility studies and pilot work that will underpin higher-risk projects in malaria, or to support investigators from other fields who are reorienting their research to malaria. It is anticipated that up to $1.5 million will be spent on awards annually, with the split between four-year awards and two-year awards to be determined during the selection process.

The awards are intended to attract more investigators to work on malaria, to encourage them to bring novel approaches to studying the pathogens and the arthropod vectors responsible for causing the disease, and to enhance scientific collaborations among investigators at the same or different institutions. Experience in malaria research is not a prerequisite. BWF seeks to encourage individuals from other fields to apply their expertise in bringing new ideas and approaches to the study of malaria. Candidates must have an M.D. or Ph.D. degree and hold a tenure-track faculty appointment or its equivalent. Applications from coinvestigators with complementary expertise to work jointly on research projects are encouraged. If a collaboration permits access to field sites or laboratory resources unique to a tropical developing country, then the collaborative partner may be an international one, so long as the lead partner is a U.S. or Canadian researcher who meets the eligibility criteria.

Scholar Awards and New Investigator Awards in Molecular Pathogenic Mycology

These awards are intended to foster the development and productivity of scientists who will bring new ways of thinking and new experimental approaches to the study of disease-causing fungi. Scholar awards provide $425,000 over five years ($85,000 per year), and new investigator awards provide $210,000 over three years ($70,000 per year). It is anticipated that three scholar awards and three new investigator awards will be made annually. The awards are intended to give recipients the freedom and flexibility to pursue new avenues of inquiry and higher-risk research projects that hold potential for advancing significantly the field of medical mycology. BWF is interested particularly in supporting scientists—including investigators already working in mycology as well as those from other fields—who will use modern techniques from molecular biology, biochemistry, immunology, pharmacology, and genetics to advance fundamental knowledge of virulent fungal pathogens. Candidates must have an M.D. or Ph.D. degree. Candidates for scholar awards must have established a record of independent research and hold a tenure-track position as an associate professor or its equivalent. Consideration also will be given to more senior investigators who are significantly reorienting their research from another field to medical mycology. Candidates for new investigator awards must hold a tenure-track position as an assistant professor or its equivalent, and they must have established a record of independent research at the faculty level.

Therapeutic Sciences

Clinical Scientist Awards in Translational Research

These awards are intended to foster the development and productivity of established independent clinician scientists who will strengthen translational research, the two-way transfer between work at the laboratory bench and clinical medicine. The awards provide $750,000 over five years ($150,000 per year). It is anticipated that 10 awards will be made annually. BWF is interested particularly in supporting investigators who will bring novel ideas and new approaches to translational research. Proposed activities may draw on the many recent advances in the basic biomedical sciences—including such fields as biochemistry, cell biology, genetics, immunology, molecular biology, and pharmacology—that provide a wealth of opportunities for studying and alleviating human disease. Candidates generally must be affiliated with a medical school; candidates at other types of institutions (including schools of veterinary medicine, public health, and pharmacy) will be considered only if they can demonstrate a plan for coordinating with institutions that provide the patient connection essential for translational research. Candidates must have an M.D. or M.D.-Ph.D. degree and hold an appointment or joint appointment in a subspecialty of clinical medicine. In exceptional circumstances, non-M.D. candidates will be considered if their work is likely to contribute significantly to the clinical enterprise; these candidates should hold an appointment or joint appointment in a clinical department. Candidates must be tenure-track investigators at the late assistant professor level or the associate professor level, or hold an equivalent tenure-track position, at the time of application. Candidates must present evidence of already having established an independent research career, as this is not a “new investigator” award. Individuals holding the rank of professor are ineligible.

New Investigator Awards in the Pharmacological or Toxicological Sciences

These awards are intended to foster the development of scientists early in their careers who will bring new ways of thinking and new experimental approaches to pharmacology or toxicology. The awards provide $210,000 over three years ($70,000 per year). It is anticipated that a total of 10 awards will be made annually. The awards are intended to give recipients the freedom and flexibility to engage in higher-risk research that holds potential for moving their respective fields in promising new directions. Candidates have considerable flexibility in proposing research activities, as both pharmacology and toxicology encompass broad areas. Indeed, BWF encourages candidates to define these fields in the broadest terms, so long as the proposed research has application to issues in either the pharmacological or toxicological sciences. Candidates must have an M.D. or Ph.D. degree and be independent investigators appointed within three years of the application deadline to a tenure-track position as an assistant professor or its equivalent. Candidates need not have appointments within established programs in pharmacology or toxicology; BWF encourages applications from researchers in such diverse departments and fields as biochemistry, genetics, molecular biology, and the physical and computational sciences. Professionals in clinical and veterinary departments who are engaged in fundamental research also are eligible to apply.

Reproductive Science

At least one of the Career Awards in the Biomedical Sciences is targeted to reproductive science annually. Qualifications for this award are outlined in the "Career Development" section. In addition, BWF supports one postdoctoral fellowship annually for physician-scientists in obstetrics and gynecology. The award, which provides $144,000 over three years, is administered in partnership with the American Association of Obstetricians and Gynecologists Foundation (AAOGF); contact AAOGF for information (804/924-9921). BWF also provides partial support for one award annually to help U.S. obstetrician-gynecologists working in the basic reproductive sciences bridge the postdoctoral years and initial faculty years. The award is made through the Reproductive Scientist Development Program (RSDP), a consortium supported by the National Institute of Child Health and Human Development, professional societies, and foundations. BWF provides $240,000 for the first three faculty years, and RSDP supports the postdoctoral years. Contact RSDP for information (415/476-9047).

Interfaces between the Physical/Chemical/Computational Sciences and the Biological Sciences

These awards continue BWF's initiative to encourage the interdisciplinary training of promising graduate and postdoctoral students from the physical, chemical, and computational sciences so they can better apply their unique knowledge and talents to biological problems. Grants of up to $500,000 per year for five years will be made to four to six degree-granting institutions. It is anticipated that grants will be made approximately every two years; the deadline for preproposals during the previous round of applications was February 1, 1998. Applicants should refer to the updated program brochure, to be released in late 1999, for revised application guidelines. The program is not intended to introduce more graduate and postdoctoral students into the research system, but rather to promote a different kind of training and to help break down the traditional barriers among disciplines at academic institutions. Emphasis will be placed on supporting new programs or existing programs that will change graduate and postdoctoral training in a meaningful way, as opposed to programs seeking more funding for conventional activities already under way. Institutions can propose graduate or postdoctoral training programs, or a combination of both. Several affiliate organizations within an institution may join together to submit an application. Consortiums representing several institutions also may submit applications, so long as one academic institution is prepared to oversee the program and administer the grant. Ancillary activities—such as undergraduate student research programs, faculty seed grants, or invited lectures—may be included as part of the proposal. However, the program's primary emphasis is on promoting the training and research activities of graduate and postdoctoral students, rather than on supporting faculty research projects.

Science Education

Student Science Enrichment Program

These awards are limited to nonprofit organizations in BWF's home state of North Carolina. BWF provides $1 million annually for this program, and awards provide up to $60,000 per year for three years. The program's goals include expanding students' competence in science, nurturing their enthusiasm about science, and interesting them in pursuing careers in research or other science-related areas. The awards are intended to support projects that provide creative science enrichment activities for students in the sixth through twelfth grades who have shown exceptional skills and interest in science, as well as those who may not have had an opportunity to demonstrate conventional "giftedness" in science but are perceived to have high potential. The projects must enable students to participate in hands-on scientific activities and pursue inquiry-based avenues of exploration—an educational approach that has proven to be the best way to increase students' understanding and appreciation of the scientific process. Projects may be conducted all year, during the school year, or during the summer. Preference is given to projects in which activities take place primarily outside of the usual school environment, such as projects that take place after school, on weekends, or during vacation periods. Eligible organizations include colleges and universities, community groups, museums and zoos, public and private schools, scientific groups, and others that can provide experiential activities for middle school and high school students. BWF encourages partnerships—for example, between scientific groups and school systems or between universities and community groups. Industries can participate in collaboration with nonprofit organizations that assume the lead role.

BWF Visiting Professorships

These awards—previously known as Wellcome Visiting Professorships—enable degree-granting institutions to bring in distinguished scientists whose interests relate to the basic medical sciences and the microbiological sciences. Professorships in the basic medical sciences are administered in partnership with the Federation of American Societies for Experimental Biology and the Canadian Federation of Biological Societies. Professorships in the microbiological sciences are administered in partnership with the American Society for Microbiology. Each year, up to 33 awards will be made in the basic medical sciences, and up to 10 awards will be made in the microbiological sciences. Awards provide $5,000, of which at least $2,000 must go to the visiting professor. Each visiting professor will spend up to five days at the host institution, where he or she will engage in teaching and discussion with students and faculty. The professor also will deliver a BWF Lecture on a subject pertinent to his or her discipline. Applications must be made by institutions wishing to host a visiting professor, not by an individual wishing to visit an institution. Nominees may come from the academic, government, or private sectors, so long as the nominees are distinguished researchers in their field. Applications are encouraged from institutions with predominantly minority enrollments, as well as from smaller institutions, newer institutions, and those located in less urban areas.

Environment for Science

These grants are intended to support activities focused on improving the environment for research. BWF makes noncompetitive grants for activities that fall outside of its competitive award programs but are closely related to its targeted areas, such as emerging infectious diseases or career development of scientists. BWF places special priority on working with nonprofit organizations, including government agencies, to leverage financial support for the Fund's targeted areas of research, and on encouraging other foundations to support biomedical research. Proposals should be submitted to BWF in the form of a letter, which should be no more than five pages. Applicants should describe the focus of the activity, the expected outcomes, and the qualifications of the organization or individuals involved; provide certification of the sponsor's Internal Revenue Service tax-exempt status; and give the total budget for the activity, including any financial support obtained or promised. Proposals are given careful preliminary review, and those deemed appropriate are presented for consideration by BWF's Board of Directors during one of its quarterly meetings.

Program Application Deadlines: 2000 Award Series

Career Development of Scientists	
Career Awards in the Biomedical Sciences	October 1, 1999
Hitchings-Elion Fellowships	August 1, 1999
Life Sciences Research Fellowships	October 1, 1999
BWF Research Travel Grants	March 1/July 1/November 1 of each year
Emerging Infectious Diseases	
Molecular Parasitology Scholar Awards and New Investigator Awards	January 15, 2000
New Initiatives in Malaria Research	January 15, 2000
Molecular Pathogenic Mycology Scholar Awards and New Investigator Awards	January 15, 2000
Therapeutic Sciences	
Clinical Scientist Awards in Translational Research	September 1, 1999
New Investigator Awards in the Pharmacological or Toxicological Sciences	November 1, 1999
Reproductive Science	
Career Awards in the Biomedical Sciences	October 1, 1999
Obstetrics and Gynecology Research Fellowships	October 1, 1999
Reproductive Scientist Development Program Research Grants	October 1, 1999
Interfaces between the Physical/Chemical/Computational Sciences and the Biological Sciences	To be announced*
Science Education	
Student Science Enrichment Program	October 15, 1999
BWF Visiting Professorships in the Basic Medical Sciences	March 1, 2000
BWF Visiting Professorships in the Microbiological Sciences	March 1, 2000
Environment for Science	Received all year

** It is anticipated that grants will be made approximately every two years; the deadline for preproposals during the previous round of applications was February 1, 1998. Applicants should refer to the updated program brochure, to be released in late 1999, for revised application guidelines.*

Note: If a date falls on a weekend or holiday, the deadline is the next business day.

ADVISORY COMMITTEES

The Burroughs Wellcome Fund uses advisory committees appointed for each competitive award program to review grant applications and make recommendations to its Board of Directors, which makes the final decisions. Members of the advisory committees are selected for their scientific and educational expertise in the program areas.

Career Awards in the Biomedical Sciences

Paul Berg, Ph.D.
Cahill Professor in Cancer Research
Director, Beckman Center for Molecular and Genetic Medicine
Stanford University School of Medicine

J. Michael Bishop, M.D.
Chancellor
University Professor
University of California-San Francisco Medical Center

Mina J. Bissell, Ph.D.
Director, Life Sciences Division
Ernest Orlando Lawrence Berkeley National Laboratory

Gail H. Cassell, Ph.D. (Cochair)
Vice President, Infectious Diseases Research
Eli Lilly Research Laboratories

Thomas R. Cech, Ph.D.
Distinguished Professor
Investigator, Howard Hughes Medical Institute
University of Colorado

Patricia K. Donahoe, M.D.
Chief, Pediatric Surgical Services
Director, Pediatric Surgery Research Laboratories
Massachusetts General Hospital

Uta Francke, M.D.
Professor of Genetics
Investigator, Howard Hughes Medical Institute
Stanford University School of Medicine

Elaine Fuchs, Ph.D.
Amgen Professor of Basic Sciences
Investigator, Howard Hughes Medical Institute
University of Chicago

Phil Gold, M.D., Ph.D.
Executive Director, Clinical Research Centre
Montreal General Hospital
Douglas G. Cameron Professor of Medicine
McGill University Faculty of Medicine

Ashley T. Haase, M.D.
Professor and Chair
Department of Microbiology
University of Minnesota Medical School

Eric R. Kandel, M.D.
University Professor, Center for Neurobiology and Behavior
Senior Investigator, Howard Hughes Medical Institute
Columbia University

Ernst Knobil, Ph.D.
Ashbel Smith Professor
H. Wayne Hightower Professor in the Medical Sciences
University of Texas Medical School-Houston

I. George Miller, M.D.
John F. Enders Professor of Pediatric Infectious Diseases
Professor of Epidemiology and Molecular Biophysics and Biochemistry
Yale University School of Medicine

Mary Lou Pardue, Ph.D.
Boris Magasanik Professor of Biology
Massachusetts Institute of Technology

Donald W. Pfaff, Ph.D. (Cochair)
Professor of Neurobiology and Behavior
Rockefeller University

Jerome F. Strauss III, M.D., Ph.D.
Luigi Mastroianni Jr. Professor
Director, Center for Research on Reproduction and Women's Health
University of Pennsylvania School of Medicine

Ian A. Wilson, D.Phil.
Professor of Molecular Biology
Chair, Structure and Chemistry Affinity Group
Scripps Research Institute

Hitchings-Elion Fellowships/BWF Research Travel Grants

Joseph T. Coyle, M.D.
Eben S. Draper Professor of Psychiatry and Neuroscience
Chair, Consolidated Department of Psychiatry
Harvard Medical School
(On leave from committee)

Elliott Gershon, M.D.
Professor and Chair
Department of Psychiatry
University of Chicago Pritzker School of Medicine

Frank M. Huennekens, Ph.D.
Member, Emeritus
Department of Molecular and Experimental Medicine
Scripps Research Institute

Suzanne R. Pfeffer, Ph.D.
Professor and Chair
Department of Biochemistry
Stanford University School of Medicine

Jenny P. Ting, Ph.D.
Alumni Distinguished Professor of Microbiology and Immunology
Immunology Program Leader
University of North Carolina-Chapel Hill School of Medicine

Christopher Wylie, M.D., Ph.D. (Chair)
Harrison Chair of Genetics and Development
University of Minnesota

Hans H. Zingg, M.D., Ph.D.
Director, Laboratory of Molecular Endocrinology
Royal Victoria Hospital
Professor of Medicine
McGill University Faculty of Medicine

Adviser (ex officio) from the Wellcome Trust, BWF's sister philanthropy in the United Kingdom:

Mary Phillips, D.Phil.
Programme Manager
International Interest Group

Molecular Parasitology/Malaria

Stephen M. Beverley, Ph.D.
Marvin A. Brannecke Professor
Head, Department of Molecular Microbiology
Washington University School of Medicine

John C. Boothroyd, Ph.D.
Professor and Cochair
Department of Microbiology and Immunology
Stanford University Medical Center

Daniel G. Colley, Ph.D.
Director, Division of Parasitic Diseases
Centers for Disease Control and Prevention

Alan H. Fairlamb, M.B., Ch.B., Ph.D.
Wellcome Principal Fellow
Department of Biochemistry
University of Dundee

Anthony A. Holder, Ph.D.
Head, Division of Parasitology
National Institute for Medical Research

Carole A. Long, Ph.D. (Chair)
Professor of Microbiology and Immunology
Allegheny University of the Health Sciences

Thomas E. Wellems, M.D., Ph.D.
Head, Malaria Genetics Section
National Institute of Allergy and Infectious Diseases
National Institutes of Health

Molecular Pathogenic Mycology

John E. Edwards Jr., M.D.
Chief, Division of Infectious Diseases
Harbor-UCLA Medical Center
Professor of Medicine
University of California-Los Angeles School of Medicine

June Kwon-Chung, Ph.D.
Head, Molecular Microbiology Section
National Institute of Allergy and Infectious Diseases
National Institutes of Health

P. T. Magee, Ph.D. (Chair)
Professor of Genetics and Cell Biology
University of Minnesota

Juneann W. Murphy, Ph.D.
George Lynn Cross Research Professor
of Microbiology and Immunology
University of Oklahoma Health Sciences Center

Phillips W. Robbins, Ph.D.
Professor of Biochemistry
Center for Cancer Research
Massachusetts Institute of Technology

Clinical Scientist Awards in Translational Research

Martin J. Blaser, M.D.
Addison B. Scoville Professor of Medicine
Professor of Microbiology and Immunology
Vanderbilt University School of Medicine

Bruce A. Chabner, M.D.
Chief, Hematology and Oncology
Clinical Director, Cancer Center
Massachusetts General Hospital

Pamela B. Davis, M.D., Ph.D. (Cochair)
Professor of Pediatrics
Case Western Reserve University School of Medicine

Susan George, M.D.
Professor of Medicine and Pharmacology
University of Toronto Faculty of Medicine

Judith G. Hall, M.D.
Professor and Head
Department of Pediatrics
University of British Columbia Faculty of Medicine

Rochelle Hirschhorn, M.D.
Professor of Medicine and Cell Biology
New York University Medical Center

Charles A. Janeway Jr., M.D.
Professor of Immunobiology
Investigator, Howard Hughes Medical Institute
Yale University School of Medicine

Barton A. Kamen, M.D., Ph.D.
American Cancer Society Clinical Research Professor
Carl B. and Florence E. King Foundation
Distinguished Chair of Pediatric Oncology Research
University of Texas Southwestern Medical Center-Dallas

Paul S. Lietman, M.D., Ph.D.
Director, Division of Clinical Pharmacology
Wellcome Professor of Clinical Pharmacology
Johns Hopkins University School of Medicine

John C. Marshall, M.D., Ph.D.
Arthur and Margaret Ebbert Professor of Medical Science
Director, Center for Research in Reproduction
University of Virginia Health Sciences Center

Jerry R. McGhee, Ph.D.
Professor of Microbiology
Director, Immunobiology Vaccine Center
University of Alabama-Birmingham School of Medicine

Judith L. Swain, M.D. (Cochair)
Arthur L. Bloomfield Professor and Chair
Department of Medicine
Stanford University Medical Center

New Investigator Awards in the Pharmacological or Toxicological Sciences

Pharmacological Sciences Panel

T. Kendall Harden, Ph.D.
Professor of Pharmacology
University of North Carolina-Chapel Hill School of Medicine

Lee E. Limbird, Ph.D.
Associate Vice Chancellor for Research
Acting Chair, Department of Pharmacology
Vanderbilt University Medical Center

Victor Ling, Ph.D.
Vice President, Research
British Columbia Cancer Research Centre

Gregory Petsko, Ph.D.
Gyula and Katica Tauber Professor
of Biochemistry and Chemistry
Director, Rosenstiel Basic Medical Sciences Research Center
Brandeis University

Palmer Taylor, Ph.D. (Cochair)
Sandra and Monroe Trout Professor and Chair
Department of Pharmacology
University of California-San Diego School of Medicine

Jeffrey M. Trent, Ph.D.
Chief, Cancer Genetics Branch
Scientific Director, Division of Intramural Research
National Human Genome Research Institute
National Institutes of Health

Toxicological Sciences Panel

Christopher G. Goetz, M.D.
Professor and Director of Movement Disorders
Associate Chair, Department of Neurological Sciences
Rush-Presbyterian-St. Luke's Medical Center

Barbara F. Hales, Ph.D.
Professor of Pharmacology and Therapeutics
McGill University Faculty of Medicine

Philip Hanawalt, Ph.D. (Cochair)
Howard and Jessie Watkins University Professor
Stanford University

Baldomero M. Olivera, Ph.D.
Distinguished Professor of Biology
University of Utah

Stephen H. Safe, D.Phil.
Sid Kyle Professor of Toxicology
Texas A&M University College of Veterinary Medicine

Thomas J. Slaga, Ph.D.
Executive Vice President, Research
AMC Cancer Research Center/Webb-Waring Antioxidant
Research Institute

Interfaces between the Physical/Chemical/Computational Sciences and the Biological Sciences

Robert L. Baldwin, Ph.D.
Professor of Biochemistry
Stanford University School of Medicine

Jeremy M. Berg, Ph.D.
Professor and Director
Department of Biophysics and Biophysical Chemistry
Johns Hopkins University School of Medicine

Jeffrey I. Gordon, M.D.
Professor and Head
Department of Molecular Biology and Pharmacology
Washington University School of Medicine

John J. Hopfield, Ph.D. (Chair)
Professor of Molecular Biology
Princeton University

James Hudspeth, M.D., Ph.D.
Professor and Head, Laboratory of Sensory Neuroscience
Investigator, Howard Hughes Medical Institute
Rockefeller University

Nancy Kopell, Ph.D.
Professor of Mathematics
Codirector, Center for BioDynamics
Boston University

Paul C. Lauterbur, Ph.D.
Head, Department of Medical Information Sciences
Director, Biomedical Magnetic Resonance Laboratory
University of Illinois-Urbana-Champaign College of Medicine

Tamar Schlick, Ph.D.
Professor of Chemistry, Mathematics, and Computer Sciences
Associate Investigator, Howard Hughes Medical Institute
Department of Chemistry and the Courant Institute of Mathematical Sciences
New York University

Michael R. Waterman, Ph.D.
Professor of Mathematics, Biological Sciences, and Computer Sciences
University of Southern California

Science Education

Carolyn Blackmon
Past Education Department Chair
Field Museum

John E. Burris, Ph.D. (Chair)
Director and Chief Executive Officer
Marine Biological Laboratory

Charles Eilber
Education Consultant and President
Charles Eilber Associates Inc.

Samuel Houston, Ed.D.
Executive Director, Center for School Leadership Development
University of North Carolina

Elmima Johnson, Ph.D.
Staff Associate, Office of Assistant Director for Education and Human Resources
National Science Foundation

Shirley M. Malcolm, Ph.D.
Head, Directorate for Education and Human Resources
American Association for the Advancement of Science

Gail Morse
Media Specialist, Hunter Elementary School
Partnerships/Technology Consultant, Public School Forum of North Carolina

Sally G. Shuler
Director for Development, External Relations, and Outreach
National Science Resources Center
Smithsonian Institution

Board of Directors

Mary Ellen Avery, M.D.
Thomas Morgan Rotch Distinguished Professor of Pediatrics
Harvard Medical School

Dr. Avery received her undergraduate degree from Wheaton College in Massachusetts and medical degree from Johns Hopkins University. She is a recipient of the National Medal of Science, and she is a member of the National Academy of Sciences, the Institute of Medicine, and the American Academy of Arts and Sciences. Dr. Avery is the Thomas Morgan Rotch Distinguished Professor of Pediatrics at Harvard Medical School and physician-in-chief emeritus at Children's Hospital in Boston. A pediatrician, her research has focused primarily on premature infants' respiratory distress syndrome, its prevention, and its treatment with pulmonary surfactant replacement. Dr. Avery joined the BWF board in 1993.

Enriqueta C. Bond, Ph.D.
President
Burroughs Wellcome Fund

Dr. Bond received her undergraduate degree from Wellesley College and Ph.D. in molecular biology and biochemical genetics from Georgetown University. She is a member of the Institute of Medicine, the American Association for the Advancement of Science, the American Society for Microbiology, and the American Public Health Association. Dr. Bond serves on the Council of the Institute of Medicine, on the Board of Regents of the National Library of Medicine, and on the Board of Scientific Counselors for the National Center for Infectious Diseases at the Centers for Disease Control and Prevention. She also serves on the board of the Institute of Medicine's Division of Health Sciences Policy and on the board and executive committee of the Society for the Advancement of Research on Women's Health, and she is chair of the board of the North Carolina Biotechnology Center. Prior to being named president of the Burroughs Wellcome Fund in 1994, Dr. Bond served on the staff of the Institute of Medicine since 1979, becoming the institute's executive officer in 1989.

Gertrude B. Elion, D.Sc.
1988 Nobel Laureate in Physiology or Medicine
Scientist Emeritus
Glaxo Wellcome Inc.

Dr. Elion received her undergraduate degree from Hunter College and master's degree in chemistry from New York University, and she holds honorary doctorate degrees from numerous universities. Dr. Elion shared the 1988 Nobel Prize in Physiology or Medicine and is a recipient of the National Medal of Science. She is a member of the National Academy of Sciences and the American Academy of Arts and Sciences, and she is a foreign member of the Royal Society. Dr. Elion worked for more than 50 years at Burroughs Wellcome Co., where she was named scientist emeritus in 1983. She currently is scientist emeritus at Glaxo Wellcome Inc. (which has no affiliation with the Burroughs Wellcome Fund) and a medical research professor of pharmacology and medicine at Duke University. Her research has focused on purine biochemistry and pharmacology and on the chemotherapy of cancer and diseases caused by viruses and protozoa. Dr. Elion joined the BWF board in 1992.

Henry G. Friesen, M.D.
President
Medical Research Council of Canada

Dr. Friesen received his undergraduate and medical degrees from the University of Manitoba. He is a fellow of the Royal College of Physicians and Surgeons of Canada and of the Royal Society of Canada, an officer of the Order of Canada, and a foreign fellow of the National Academy of Sciences. Dr. Friesen was named president of the Medical Research Council of Canada in 1991. He previously had served at the University of Manitoba as professor and head of physiology and as professor of medicine. A specialist in endocrinology, his research has focused on the mechanisms of action of prolactin and growth hormone. Dr. Friesen joined the BWF board in September 1995.

Samuel L. Katz, M.D. (Chair)
Wilburt C. Davison Professor and Chair Emeritus
Department of Pediatrics
Duke University School of Medicine

Dr. Katz received his undergraduate degree from Dartmouth College and medical degree from Harvard Medical School. He is a member of the Institute of Medicine. He is a scientific councilor at numerous biomedical institutions, and he chairs advisory committees and panels for the Centers for Disease Control and Prevention and for the World Health Organization. Dr. Katz is the Wilburt C. Davison Professor and chair emeritus of pediatrics at Duke University School of Medicine. Long interested in infectious diseases and vaccines, he currently is focusing on the possibility of global elimination of measles early in the next century, on the control of other vaccine-preventable diseases in both the United States and the developing world, and on clinical investigations of pediatric HIV/AIDS. Dr. Katz joined the BWF board in 1992 and has been its chair since April 1995.

David M. Kipnis, M.D.
Distinguished University Professor of Medicine
Washington University School of Medicine

Dr. Kipnis received his undergraduate degree from Johns Hopkins University and medical degree from the University of Maryland. He is a member of the National Academy of Sciences, the Institute of Medicine, and the American Academy of Arts and Sciences. Dr. Kipnis is Distinguished University Professor of Medicine at Washington University School of Medicine. His research has focused on the immunological and pathophysiological mechanisms responsible for the various forms of diabetes mellitus. Dr. Kipnis joined the BWF board in 1994.

Daniel Nathans, M.D.

1978 Nobel Laureate in Physiology or Medicine
University Professor of Molecular Biology and Genetics
Senior Investigator, Howard Hughes Medical Institute
Johns Hopkins University School of Medicine

Dr. Nathans received his undergraduate degree from the University of Delaware and medical degree from Washington University. He shared the 1978 Nobel Prize in Physiology or Medicine and is a recipient of the National Medal of Science. He is a member of the National Academy of Sciences and the American Academy of Arts and Sciences. Dr. Nathans is University Professor of Molecular Biology and Genetics and a Howard Hughes Medical Institute Senior Investigator at Johns Hopkins University School of Medicine. His research has focused on viruses that cause tumors in animals, and he currently is studying cellular responses to growth factors. Dr. Nathans joined the BWF board in 1994.

Joseph S. Pagano, M.D.

Lineberger Professor of Cancer Research
Director Emeritus, Lineberger Comprehensive Cancer Center
University of North Carolina-Chapel Hill School of Medicine

Dr. Pagano received his undergraduate degree from the University of Rochester and medical degree from Yale University. He is a member of the Institute of Medicine, the Association of American Physicians, and the American Society of Microbiology. He is chair of the Association of American Cancer Institutes and has served as president of the International Association for Research on Epstein-Barr Virus. Dr. Pagano is the Lineberger Professor of Cancer Research and director emeritus of the Lineberger Comprehensive Cancer Center at the University of North Carolina-Chapel Hill School of Medicine. His research has focused on the regulation of Epstein-Barr viral gene expression and on the mechanisms of actions of antiviral drugs. Dr. Pagano joined the BWF board in 1993.

Philip R. Tracy, LL.B.

Former President and Chief Executive Officer
Burroughs Wellcome Co.

Mr. Tracy received his undergraduate degree from the University of Nebraska and law degree from George Washington University. He joined Burroughs Wellcome Co. in 1974 as assistant general counsel, and he served as the company's president and chief executive officer from 1989 until its acquisition in 1995. Mr. Tracy currently is Of Counsel to the North Carolina-based law firm of Smith, Anderson, Blount, Dorsett, Mitchell & Jernigan, L.L.P. Among other business interests, he is a venture partner with Intersouth Partners IV, a venture capital firm that invests in early-stage life science and technology companies, and he serves on the board of directors of numerous organizations. Mr. Tracy joined the BWF board in 1989.

Lowell P. Weicker Jr., LL.B.
Former Governor, Connecticut
Former member, U.S. Senate and House of Representatives

Gov. Weicker received his undergraduate degree from Yale University and law degree from the University of Virginia, and he holds honorary degrees from more than a dozen colleges and universities. He has served in the Connecticut House of Representatives and as governor of Connecticut. He also has served in the U.S. House of Representatives and the U.S. Senate (1970-88). During this time, he fostered support for the National Institutes of Health and numerous other major research and health programs. Among many honors, Gov. Weicker has received an Albert Lasker Public Service Award, and the National Institutes of Health and the University of Connecticut have dedicated buildings in his name. He currently is a visiting professor at the University of Virginia, teaching at the undergraduate, law, and medical schools. Gov. Weicker joined the BWF board in 1996.

Jerry L. Whitten, Ph.D.
Dean of Physical and Mathematical Sciences
Professor of Chemistry
North Carolina State University

Dr. Whitten received his undergraduate degree and Ph.D. in chemistry from Georgia Institute of Technology, and he was a research associate at Princeton University. He has been named an Alexander von Humboldt U.S. Senior Scientist, and he is a member of the American Chemical Society and the American Physical Society. Dr. Whitten is dean of physical and mathematical sciences and professor of chemistry at North Carolina State University. A theoretical chemist, his research has focused on electronic structure theory and its application to materials and catalytic processes. Dr. Whitten joined the BWF board in 1993.

In Memoriam

George Herbert Hitchings Jr., Ph.D.
1905-1998

George H. Hitchings Jr., who served as the Burroughs Wellcome Fund's president from 1974 to 1990, died on February 27, 1998. Dr. Hitchings worked for more than five decades as a research scientist at Burroughs Wellcome Co. Among numerous honors, he shared the 1988 Nobel Prize in Physiology or Medicine for a series of scientific breakthroughs that revolutionized the world of drug exploration and design. It was Dr. Hitchings's leadership at the Burroughs Wellcome Fund that reinforced BWF's belief in the essential link between basic research and practical applications in medicine.

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